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ABSTRACT

A teacher education program intended to increase the variety of questioning techniques employed by science instructors is presented and evaluated. Used by four different groups of secondary teachers, this module presents a question category classification structure based on the Aschner-Gallagher system, but modified to be specific for science teaching. The bulk of instruction is intended to be done by the programmed materials which are provided and a provision is made for self-assessment. From the four groups who voluntarily participated in the program, the author found significant increases in the variety of questions used in teaching by groups composed of student teachers and graduate students, but non-significant increases for two groups of inservice science teachers. Suggestions for the improvement of the module from both those who have participated in the training groups and the author of the module are included. (CP)

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AN EFFECTIVE PROTOCOL MODULE FOR TRAINING SCIENCE TEACHERS TO ASK A WIDE COGNITIVE VARIETY OF QUESTIONS

by

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I- Brief Description of the Module

Research in teacher training, cost estimates, and transportability were all used as criteria for developing the module. The final product included the following components:

(1) A propaganda paper designed to convince the teacher that using a wide cognitive variety of questions would help them to enhance student achievement in science.

(2) A very brief summary of module objectives. This summary was not an extensive list of behavioral objectives.

(3) A question category classification system based on the Aschner-Gallagher system (1) but modified to be specific for science teaching.

(4) Written programmed instruction designed to train teachers to accurately identify the question categories. The programmed instruction comprised the bulk of the module and included not only identification of single questions but transcript analysis, category description, discrimination, and question writing tasks. Transcripted episodes and all examples of questions were derived from audiotapes of natural classroom science teaching. Transcripted episodes were selected using the criterion of modeling the desired behavior.

(5) Mastery tests -- transcript analysis tasks of considerable complexity and length.

(6) Audiotaped Protocols -- the audiotaped component contained a short verbal essay on the importance of analyzing one's art for self-learning and improvement, then a series of short simple teaching episodes leading to longer and mre complex teaching episodes which the teacher was expected to analyze. All episodes included in the audiotaped component were also selected from tapes of natural classroom teaching.

(7) Self-analysis -- As a final task, teachers were encouraged to audiotape their own science teaching and to analyze it using their newly acquired skills.

Completion of the entire module required an average time of 6 1/2 hours. Minimum completion time was 4 1/2 hours. Maximum completion time was 12 hours 15 minutes.

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II- Summary of Evaluation Studies

Evaluation studies were conducted with four groups: student teachers in secondary science, volunteer inservice teachers employed by a medium sized city school system, volunteer inservice science teachers employed by small rural schools, and non-volunteer inservice science teachers from small rural schools who completed the module as a graduate course requirement. Both non-volunteer grous (student teachers and graduate students) began to use a wider cognitive variety of questions in their teaching following their encounter with the module. The volunteer rural teachers increased the cognitive variety of their questions slightly but not significantly ($p = 0.30$) while the volunteer urban teachers did not change ($p = 0.91$). Questionnaires indicated that not all participants in the latter two groups completed the module. (In fact, some of the module packages were returned by the "volunteer" urban teachers with the seals intact!) A detailed discussion of the evaluation studies can be found in (2).

III- Suggestions for Improving the Module

Evaluation questionnaires filled out by participant teachers, informal conversations between the author and some of those teachers, and non-systematic observations indicated that a number of modifications in module design might enhance its effectiveness. The major problems centered around the time required to work through it and the technical quality of both printed and audiotaped components.

Time demand seemed to be a function of several inter-related variables, the most important of which was probably the complexity of the question category classification system. At the time the author was developing the module, he was unaware of a very similar system developed by Blosser (3) which had already had many of the kinks ironed out of it. I would use Blosser's system in any revision of the module for three reasons. (1) Her system is easier to comprehend. (2) The other system is an unnecessary duplication. What science education does not need is yet another slightly different question category classification system. (3) Blosser's book is an excellent one for using in secondary science methods courses. Using her system for the module would allow continuity from methods course to student teaching.

Because Blosser's system is also quite complex, some basic changes should be made in the programmed instruction regardless of which system is used. The number of extended transcripts within the program should be reduced, with more emphasis placed on discrimination among the more difficult categories by including more single question identifications and short episode analyses. Additionally, emphasis should be placed on possible codings rather than correct codings, especially with the

more difficult categories. This would give the teachers more opportunity to perceive success and might make working through the module seem shorter.

The problem of technical quality can be easily eliminated from any revision of the module. The "home made" nature of the printed materials (all typing, mimeographing and art work done by the author) may have detracted from the effectiveness of the module. The rather poor technical quality of even the best audiotapes certainly detracted from module effectiveness. Technical quality problems almost certainly increased work-time by an unknown amount. While the author made a point of deriving audiotape protocols from in-class recordings, this is not absolutely necessary. Persons working through the module should perceive the audiotaped episodes to be real. This can be effected by using the transcripts as scripts, obtaining drama students to role play, and recording the audiotapes under studio conditions.

The verbal essay should be eliminated and the remainder of the commentary accompanying the protocols should be reduced to little more than direction giving. The percentage of time devoted to background music should be considerably shortened and the nature of the background music changed. (The background music used by the author can best be described as very funky jazz rock; affective response to the music was generally quite intense with direction being age dependent. If the module is intended for general use, music with general appeal should be used.)

A complete copy of the module appears below, including scripts of the audiotaped component. The author grants permission for reproduction of these copyrighted materials so long as the users are using them for non-commercial purposes. Anyone desiring to use some or all of the materials for commercial purposes should contact the author.

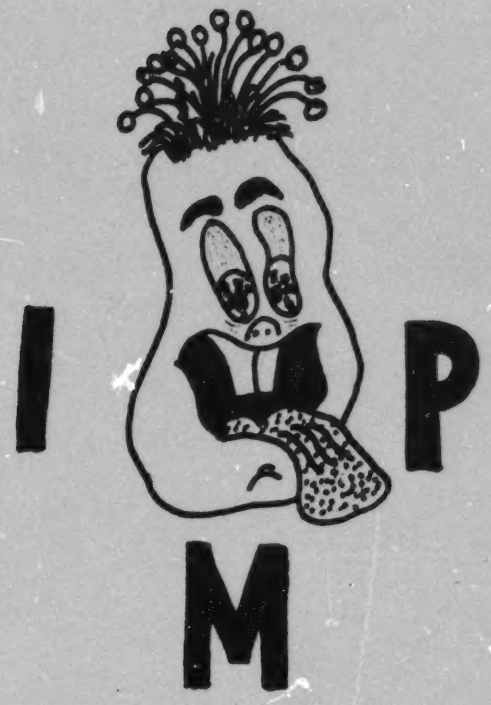
REFERENCES

1. Aschner, Mary Jane, et al, A SYSTEM FOR CLASSIFYING THROUGH PROCESSES IN THE CONTEXT OF CLASSROOM VERBAL INTERACTION, Institute for Research on Exceptional Children, University of Illinois, Urbana, Illinois [1965]. USOE Cooperative Research Project no. 965

2. Lamb, William G., THE DEVELOPMENT AND EVALUATION OF A MODULE DESIGNED TO TRAIN SECONDARY SCIENCE TEACHERS TO ASK A WIDE COGNITIVE VARIETY OF QUESTIONS, unpublished Ph.D. dissertation, The University of Texas at Austin, Austin, Texas [1975]

3. Blosser, Patricia E., HANDBOOK OF EFFECTIVE QUESTIONING TECHNIQUES, Education Associates, Inc., Worthington, Ohio [1973]

APPENDIX A



INDIVIDUALIZED MODULAR PROTOCOL

CATEGORIZING QUESTIONS IN CLASSROOM

LOOSE SHEETS INCLUDED WITH INTRODUCTION BOOKLET

Since the IMP--"Categorizing Questions in Science Classes"--was first written and assumbled, several new pieces have been added which are not mentioned on the first page of the INTRODUCTION TO THE MODULE.

These include:

(a) The sheet you are reading now to explain all the other additions.

(b) A sheet entitled "Steps for Wroking Through the Module" which gives more complete directions than the introduction booklet, directions which include the added components.

(c) A sheet which explains more fully the nature of the examples, transcripts, and episodes around which the module is constructed.

(d) A very short one-page summary of the question category classification system for use in coding transcripts and audiotaped episodes (but <u>not</u> for use in working through the written program except when transcripts are being coded).

all the above have been inserted
in the introduction booklet

(e) A sheet entitled "Directions for Coding Audiotaped, Videotaped, and/or Live Classroom Episodes for the Types of Questions Science Teachers Ask." This sheet was included in the original module but was inadvertantly omitted from the introduction booklet directions. It will be found in the stack as it emerges from the envelope under the written program exit assessment and above the audiocassette.

(f) Six (6) coding sheets for use in coding audiotapes, live classes, etc., which are paperclipped to the "Directions for Coding Audiotapes. . . ."

(g) A sheet asking you to estimate the amount of time you spend in working through each component of the module.

(h) An evaluation form which you should complete after working through the module.

THANKS FOR OVERLOOKING
THE SEMI-DISORGANIZATION.

ALL QUESTIONS, EXAMPLES, TRANSCRIPTS, AND AUDIOTAPES ARE FROM LIVE IN-CLASS RECORDINGS. FOR THE WRITTEN EXAMPLES AND TRANSCRIPTS, THE NAMES HAVE BEEN CHANGED "TO PROTECT THE INNOCENT" BECAUSE MANY OF THESE EXAMPLES HAVE BEEN DERIVED FROM TAPES OF TEACHERS WHO ARE NOW TEACHING IN THE AUSTIN INDEPENDENT SCHOOL DISTRICT AND MANY OF THE STUDENTS PROTRAYED IN THE TRANSCRIPTS ARE STILL STUDENTS IN AUSTIN SCHOOLS. AN ACCURATE PORTRAYAL OF CLASSROOM DIALOGUE HAS BEEN ATTEMPTED, EVEN TO THE EXTENT OF REPRODUCING DIALECTS, PAUSES, AND SO FORTH. IN ONE INSTANCE, SOME EXPLITIVES WERE DELETED (just like the politicians) BUT THE REPRODUCTION OF CLASSROOM DIALOGUE (and multilogue) IS AN OTHERWISE ACCURATE REFLECTION OF WHAT REALLY HAPPENED IN THE CLASSROOM. THE EXAMPLES OF TEACHING FOR BOTH THE WRITTEN COMPONENT OF THE MODULE AND THE AUDIOTAPED COMPONENT WERE GENERALLY CHOSEN AS POSITIVE EXAMPLES OF THE USE OF QUESTIONING BY TEACHERS: THERE IS ONE WRITTEN TRANSCRIPT WHICH DOES NOT REPRESENT WHAT THE AUTHOR WOULD CONSIDER TO BE GOOD OVERALL TEACHING STRATEGY BUT WHICH DOES REPRESENT FAIRLY GOOD USE OF QUESTIONS IN TEACHING.

STEPS FOR WORKING THROUGH THE MODULE

(1) Read the INTORUCTION BOOKLET to obtain an overview of the module.

(2) Work through the introduction booklet, following the directions carefully. While working through the written program, you will need both the KEY BOOKLET and the INTRODUCTION BOOKLET, so keep these handy.

(3) Analyze the transcripts in the WRITTEN PROGRAM EXIT ASSESSMENT. After working through the written program, you should be able to code transcripts at the 80% accuracy level. The final objective of the module is a 70% accuracy level for coding live classroom process. Because coding written transcripts is much easier than coding classroom process as it flows by you, you should not advance to the next step (the audiotaped component of the module) until you have achieved the 80% accuracy level for coding transcripts.

(4) Listen to the audiotape and follow the directions. Again you will need both the key booklet and the introduction booklet. The audiotape has two sides.

(5) Analyze your student teacher's teaching at every opportunity. Specific suggestions for doing this are included in the module and need not be discussed at this point.

(6) Give your student teacher feedback on the questions he or she asks. If they are using questions well, tell them. If they are not, make some positive suggestions regarding ways in which they can improve their questioning skills.

(7) Fill out the evaluation form included at the end of the module and, if you wish, write out any comments, questions, suggestions for improvements, examples, and so forth you feel would be helpful to us in revising this module for next year's student and co-operating teachers.

USE THIS KEY AS A MEMORY AID FOR CODING TRANSCRIPTS AND ON-GOING CLASSROOM PROCESS.

CATEGORY	DESCRIPTION
1	Managerial, Procedural and Rhetorical Questions
2A	Memory-recall and Identification Questions
2B	Observation and Translation Questions
3A	Questions asking the student to use a learned or previously given formula, method, logical sequence, or classification system to produce a correct answer.
3B	Questions which ask student to infer or predict from data and observations or to cite their reasons.
3C	Questions which require extended reasoning to produce the one acceptable answer, i.e. analysis questions, identification of assumptions underlying a sequence of reasoning, etc.
4A	Completely open questions with many possible right answers.
4B	Classification type questions for which student make up criteria; Experimental design questions; Prediction from an inadequate data or observation base
4C	Hypothesis formation when hypothesis has not been previously studied. Synthesis type questions.
5A	Simple agree/disagree and yes/no evaluation questions for which either alternative is equally acceptable.

CATEGORY	DESCRIPTION
5B	Questions which ask students to judge or rate several items, ideas, proposals, etc.; Questions which ask students to choose among several alternatives.

INTRODUCTION BOOKLET

WORKING THROUGH THE MODULE: OVERVIEW

The IMP "Categorizing Questions in Science Classes" consists of three written parts which describe tasks for you to do. The first part is a written program designed to familiarize you with the question category terminology and to let you practice categorizing questions derived from audiotapes of secondary science lessons. The second part is the audiotaped instruction and is designed to give you practice in using the category under combat conditions--coding questions recorded in secondary science classes as they flow past you at the rate of classroom use. The third part is an audiotape you will make of your own teaching; you should record yourself teaching a lesson for which the use of question is appropriate so that you can use the category system to analyze the kinds of questions you use.

Support materials for these three portions of the module include this introductory booklet which describes the question category system and explains the coding rules as well as introduces the philosophy behind the module, a key booklet which contains the coding keys for transcripts included in the written program and for episodes recorded on the audiotaped instruction, and a written program exit assessment which contains two extended transcripts by which you may evaluate your competence at coding transcribed science lessons prior to beginning the audiotaped instruction.

Now would be a good time for you to check your IMP package to be sure everything is included. You should have:

(1) INTRODUCTION TO THE MODULE: The Category System--Description of the Categories and Coding Rules
(2) Written Program
(3) Key Booklet
(4) Written Program Exit Assessment
(5) Audiocassette containing audiotaped instruction.

If you have everything, please turn to the next page which described a bit of the philosophy and rationale underlying the IMP; Categorizing Questions in Science Classes.

INTRODUCTION

One of the most important skills possessed by any teacher is the ability to ask good questions. Whether a teacher is conducting an inquiry lesson, attempting to get students to draw inferences from experimental data, evaluating student understanding of some point before proceeding with the lesson, conducting a review of a unit of study, or conducting some other activity, questions are every teacher's stock-in-trade.

Several research studies over the years have shown that most teachers ask memory-recall questions almost exclusively. There is nothing "wrong" with learning discrete facts and, contrary to the opinions of many persons, the thought processes related to memory are still thought processes. BUT--memory is only one thought process among many and research has shown that a person who has natural ability for one type of thought process does not necessarily have natural ability for another type of thought process. For example, a student who is a a good memorizer might not have much ability for reaching conclusions by examining experimental data. A second student might not be good at either memorizing facts or interpreting experimental data but might possess ability in evaluating solutions which have been proposed for a particular problem. A third student might be able to generate several excellent alternative responses to an open question but might not be as able as his/her peers in memorizing, interpreting, or evaluating. Research has also indicated that training for one type of thinking does not necessarily effect improvement in other thoughtprocesses even though a common-sense analysis of the thought processes indicates that they should be related to each other. (Once again, as is common with many psychological phenomena, what makes "sense" is not necessarily what happens in real life.)

What does all this have to do with asking questions? Well, different kinds of questions require different kinds of thinking, different thought processes, to produce answers. A teacher who wishes to take advantage of the varying cognitive abilities of individual students should ask many different types of questions. A teacher who wishes to help students to develop the many different kinds of thought processes should ask many different types of questions. And at a more practical level, the teacher who wishes to keep the class from getting bored with one type of question will also ask many different types of questions.

A. STUDENT TEACHERS

How can you learn to ask many different types of questions? Research in teacher education indicates that most teachers do not recognize the difference between different types of questions. Also, teachers who learn to identify different types of questions as they are used in the classroom use more different types of questions than teachers who do not learn to identify question types. This module is designed to help you learn to identify many different types of questions that are used in teaching secondary science. The category system which you will learn has been derived from the research on different thought processes and also from listening to hours of real-life science instruction. You will learn to use the category system by identifying questions--written and then audiotaped--asked by real teachers conducting science lessons with adolescents in the public schools. You will then be asked to analyze your own teaching via audiocassette for the types of questions you ask.

B. CO-OPERATING TEACHERS

One of the reasons why student teachers ask only one or two types of questions is because their teachers have used only one or two types of questions; they are familiar with only one or two types. Also, they often do not realize they are asking only one or two question types. Research has shown that co-operating teacher feedback is one of the most important variables in helping student teachers to improve their questioning, and that feedback concerning objectively observable and specifically

definable types of questions is more effective than general feedback.

This module is designed to help you learn to categorize the questions asked by your student teacher. By actually categorizing written and audiotaped questions and short teaching sequences, you will learn a category system which was derived from the research on types of thought processes and from listening to hours of audiotapes of secondary science teachers using questioning. All of the questions used in designing this module were derived from "real-life" secondary science lessons being taught by real teachers to real adolescents in the public schools.

Once you have learned this system of classification, we urge you to use the system in observing your student teacher. In so doing, you will be able to give the student teacher <u>specific</u> feedback concerning the use of questions. For example, rather than communicating a vague feeling of disquiet and dissatisfaction, you might be able to tell them that they asked 10 rhetorical and 40 memory-recall questions during a 10-minute period and then to suggest some more appropriate types of questions or some different types of question they might use.

THE CATEGORY SYSTEM

1- Managerial-rhetorical questions

This category includes all those questions which students are really not expected to answer and those questions which imply a point of view with which the students are expect to agree. Also included are questions which students are expected to answer with a "yes" or "no", providing the teacher with information needed to conduct the lesson. Examples are:

"Charles, would you like to sit down and be quiet so we can proceed with the discussion?"

"Can everybody see this?"

"Did ya'll all understand Bobby's answer?"

"Carol, you said that the bubbles disappeared when you added the liver, right?"

"Don't you think we should put a thermometer in the beaker to record any possible changes in temperature?"

2- Cognitive-memory questions

A- Level A

The first level of this category includes questions which ask students to remember previously learned materials or to identify something they see, hear or otherwise sense by a learned name or label. The 2-A category includes the infamous memory-recall question (the "KNOWLEDGE" level in Bloom's Taxonomy). Examples of memory-recall questions are:

"What is the phylum of a frog, Michelle?"

"What are the six major experiments which led to the development of modern atomic theory, Bob?"

Examples of identification questions included in category 2A are:

"Susan, what is the name of this apparatus?" (holding it up)

(teacher playing a recording of train approaching then receding, while blowing whistle) "What kind of effect did you just hear, Sean."

B- Level B

2B questions include those which ask students to describe previously learned, read, heard, etc., material or statements in their own words. Most questions of this nature would be called "translation" questions by Bloom. An example is:

> "You just mentioned something about setting up a 'control' in the experiment, Bob. Would you tell us in your own words just exactly what you mean by the word 'control' when you're talking about an experiment?"

This type of question is often used with a probing strategy by many science teachers. Another type of question included in this category 2B are those questions which ask students to describe observations in their own words. Examples include:

> "What did you see happen when we put the flask in ice?"
>
> "What did group 4 get when you measured Alfred's heartbeat, Sandra?"

Questions of this nature are commonly asked during a post-lab or a demonstration.

3- Convergent-production questions

This type of question requires a best or a right answer, the acceptability of which can be judged by an objective set of criteria developed by someone prior to the asking of the question. The criteria may or may not be known to the student but the teacher should know them. The trick is--no matter how "hard" a question is, if there is only one right answer and if it is not coded as a 1 or as 2 A or B, it should be coded as some level of category 3.

A- Level A

Common to this category are questions which require students to use a learned or given sequence of reasoning in producing the right answer. Common examples of this question type occur in science classes when students are confronted with new examples of a type of problem they have already learned to solve--e.g.,

> "O.K., Harvey just calculated the concentration of ethyl acetate starting with one mole of each reactant. Now, Mary, if you added 2 moles of acetic acid, 1 mole of water, and 3 moles of ethanol and mixed them up, how much ethyl acetate would be present when the reaction reached equilibrium?"

Another example of this type of question which commonly occurs in science classes is:

> "Using the characteristics listed on the board, tell me which of the following common organisms are mammal and which are not, Rowena?"

With this question, the student is expected to classify, using a given system or set of criteria. Any question which asks for comparison, contrast, classification, etc., using a given or learned system or set of criteria is also 3A.

B- Level B

Questions of category 3B require the student to deal in some way with relatively unambiguous data and with the inferences drawn therefrom. They occur most typically in post-lab or demonstration lessons. Another type of question which is also categorized as 3B are questions which ask a student to cite the reasons or criteria used in producing a previous assertion or answer. Questions of this latter type are also often used as probes. Examples of 3B questions are:

> "Why do you think the period of the pendulum will be longer if we raise the bob before letting it go, Harold?"
>
> "What do you think the temperature of the water would have been had we let the water boil for another 30 seconds, Marie?"
>
> "You missed the measurement of your plant on Thursday but you have the height for every other day. If you had to guess, using your other date, what would you say the height of the plant was on Thursday?"
>
> "You just finished measuring the boiling point of water. Does this data tell you anything about what the boiling point of alcohol might be, Larry?"
>
> "Which of the temperatures listed on the board seem to be the most likely as the melting point of PDCB, given your experimental results, Sharon?"

In some cases (e.g., prediction of established trends), this type of question might be structured using learned or given principles, and so forth, rather than lab data. For example, after lecturing on the gas laws, a teacher might ask a student to predict whether or not a balloon would expand, given certain well-defined conditions. Most questions defined as "Application" in Bloom's Taxonomy are included in category 3B of this system.

C- Level C

These are questions which require a student to produce the solution to a problem, a conclusion, an explanation, etc., which is best or correct when the student does not know and has not learned the logical sequence which is associated with a high probability of producing the best or correct solution, conclusion, or explanation. Another type of question classified as 3C is what Bloom calls "Analysis" questions, when the analysis is expected to produce a best or correct answer. A third type of question classified as 3C includes those questions which ask students to identify the assumptions underlying certain statements (in a sense, discovering the underlying assumptions requires analysis so this third type of question might be viewed as a sub-type of analysis questions). Examples of 3C questions are:

> "Now, we have all the steps of the experiment written on the board. I'm going to ask someone whether or not performing this experiment will really provide an answer to the original question, or whether there's still something that you're leaving out. I'll give you a few seconds to think about it before I select my victim."
>
> "Bobby, you said that the balloon would expand and everyone agreed with you when we voted because you gave such good reasons. When we did it though, the balloon contracted instead. Why do you suppose that happened? What were you assuming when you listed your original reasons for believing the balloon would expand that's not actually correct?"
>
> "You've run a bunch of experiments where you varied the amount of force and the weights sitting on the car and where you measured the acceleration of the car. Can you take that data from those experiments and find a rule or a law or formula which would allow you to figure out ahead of time almost exactly what was going to happen, Julio?"

4- Divergent-production questions

Divergent-production questions allow for a large range of acceptable answers. The criteria of acceptability may be either objective or subjective and may be determined by the teacher, the student(s) or someone else. The key to all category 4 questions is that they have more than one, and usually many possible, right answers.

A-Level A

This level includes questions which are completely open and questions which require a factual type of answer but for which the range of responses is very wide. An example of a completely open question is the famous

"What is one use for a brick?"

Answers to this question can range from "you can build houses with bricks," to "you can grind it up, mix it with water to make clay, and use it to sculpt a caricature of the principal." Examples of 4A questions which require a factual type of answer to be chosen from a wide range of acceptable responses are:

"Will you name a fruit or a vegetable, Bob?"

"What is one example of a metal, Sheila?"

"Where is one volcano located, Sammi?"

B- Level B

Category 4B includes three types of questions commonly asked in science classes: classification type questions for which the student is expected to generate the criteria for classification, questions which ask the student to predict an occurence from certain conditions when they must generate the criteria for choosing which conditions to which they will attend (i.e., they do not know the general principles which are applicable and have not conducted any organized experiments relating to the occurence being predicted), and questions which ask students to propose ways in which previously established questions or statements can be tested (i.e., experimental design questions). These three types of questions have in common a wife variety of possible answers which are acceptable but which must still meet certain criteria of acceptability. In addition, the answers are not "factual" in the sense that they have been learned; the answers are logical possibilities. Also, in each case, the student is generating the criteria for the answer he or she produces, but the student's criteria are or can be evaluated using some objective criteria as well. Examples of 4B questions are:

"How do you tell the difference between fruits and vegetables?"

"What criteria could you use for deciding whether any of these minerals are valuable or not?"

"When we mixed those two chemicals together, the solution stayed colorless for about ten seconds before it turned to dark blue. What would happen if we added about 10 ml. of water to each of the solutions before we mixed them together? Would it take less time, the same time, or more time to change to dark blue?"

"How would you go about finding out whether or not liquids are affected by thermal expansion, Ernest?"

4B questions are quite common in many science classes. Some teachers give a hypothetical set of conditions to begin a pre-lab, eliciting predictions of the outcome from several students and probing some of them to determine the reasons and/or underlying assumptions on which their predictions are based (3B and 3C questions). Then they use questions to determine the design of an experiment which might distinguish between the probability or correctness of the different predictions. The classification questions are most common to life and earth sciences where the teachers seem to be more concerned with classification than do physical science teachers. Although much early chemistry was classificatory in nature, chemistry teachers do not seem to use classification questions very much. Perhaps they should.

C- Level C

Questions in category 4C include hypothesis formation and what Bloom calls "Synthesis" questions. Sometimes the level of the students must be considered when coding such questions. For example,

"Why is the hot water staying on the top and the cold water staying on the bottom, Roosevelt?"

would certainly be a 4C question for ninth graders who had not previously studied the relationship between temperature and density. On the other hand, this same question would almost as certainly be coded as a 2A for college-bound seniors in an advanced physics class. Typically, "why" questions such as

"Hmmmmm. It took the mixture 20 seconds longer to change colors this time. How do you explain this, Margarite? Why did it take longer to change this time?"

"Why do you suppose the period of the pendulum was the same even though you lifted the bob a little higher before releasing it?"

should be coded as 4C if the students have not been expected to memorize the answer beforehand.

5- Evaluation questions

A- Level A

Category 5A includes questions which ask students if they agree or disagree with some statement, point of view, answer, etc., etc. Both answers should be equally as acceptable--"disagree" should be as correct or acceptable as "agree". If this is not the case, the question should not be coded as 5A.

B - Level B

Category 5B contains 3 types of questions: questions which ask the student to express a value judgment in terms of a scale of values provided by the responding student, questions which are similar to those just described except that someone other than the student (usually the teacher) furnishes the scale of values prior to the student's response, and questions which ask the student to choose from among alternatives which are provided. Examples of 5B questions are:

"What do you think about this method of solvong the problem?"

"If you were a pregnant mother and you contracted a severe case of measles, would you get an abortion or would you have the baby? Remember, there is a good possibility that your babe, if allowed to be born, would have a birth defect. Sandy?"

"O.K. We've only got two kidney machines and there are 10 people who have to use it in order to live. If they do not get to use the kidney machine they will die and you must pick out the two people who get to live; the 8 people people who do not get to use a kidney machine will certainly die. You have a handout which gives you the information which is available on these ten people so read it carefully and pick out the two you wish to use the kidney machine. (LONG PAUSE). O.K., Jesus, which two people did you pick out?"

A word about the question category classification system.

The numbers and letters used to designate the different categories are intended only as category identification symbols and are not intended to convey any scale of values to be attached to any one category of question. For example, Category 4A should probably not be considered as "higher level" than Category 3C. 5A questions might or might not be considered

"higher level" compared to 2B questions. One should not assume that questions categorized with larger numbers and letters are more desirable. Types of questions, like other strategies and techniques which teachers use, should be appropriate to the objective.

On the other hand, a model of teaching is very definitely being implied in the category system. The model teacher is one who consistently uses several different types of questions, asking questions at several levels and with differing ranges of difficulty and ranges of acceptable answers. The model teacher implied by this category system might not use all eleven types of questions in one lesson or two lessons, but he or she would definitely use most of the categories over a period of several lessons. The lesson on one day might be a pre-lab with many 4B, 3B and 3C questions. The associated post-lab lesson would include 2B, 3B, 3C and 4C questions. On another day, a lesson designed around an issue in science or on the relationship between science and society might include many 5A and 5B questions as well as 2A, 3B, 4A, etc., questions. On yet another day, the teacher might conduct a review session, asking mostly 2A, 2B, and 3A type questions. The criterion of good teaching implied by this question category classification system is variability in using different types of questions. This is not the only criterion of good teaching but it is one of them, and it is the criterion which can be addressed using the system above.

DECISION RULES FOR USING THE CATEGORY SYSTEM: how to decide between two similar categories--resolving some ambiguities.

1- When in doubt, code any question as a lower number and letter. If you aren't sure whether or not more than one answer is acceptable, assume that only one answer is acceptable. If you can't tell whether or not the students are expected to have studied the subject on which they are being questions, assume that they are expected to have studied the subject. The reason for this rule is that most teachers ask mostly memory-recall questions and convergent-production questions; regardless of what a teacher may intend, if the question and/or the context are at all ambiguous, the students will react to questions as if they were memory-recall and convergent-production questions simply because those are the kinds of questions they are accustomed to.
   (a) If you are not sure from context whether or not students are being asked to infer from an adequate data and/or theoretical base, assume that they are (code 3B in preference to 4B).
   (b) If you're not sure from context whether an agree/disagree question is a 1 (student is expected to agree with the point of view implied by the teacher) or a 5A (either the agree or disagree response is equally as acceptable to the teacher), assume that it is a 1. Usually the student's response tone is a good clue to distinguishing between these types of questions.

(c) If the context does not provide sufficient clues for deciding whether students have previously been exposed to a method for working a problem to produce a right or best answer (the difference between a 3C and a 3A), assume that they have and code the question a 3A.

(d) If the context does not provide sufficient clues for distinguishing between synthesis or divergent hypothesis questions (4C) and similar questions to which the teacher will accept only the "right" or best answer (3C), assume that only one answer is acceptable and code 3C.

(e) If the context does not provide sufficient clues for distinguishing between 4C questions and questions for which the answer has been learned (2A) or for which a method of generating an answer has been learned (3A), assume that the answer or method has been learned and code accordingly.

(f) All rules have exceptions. The exception to this rule is: A question that sounds completely open should be coded as a 4A even if it is not clear in context that the teacher really wanted to ask a different kind of question and just didn't phrase the question properly. If the teacher asks a second question, adding criteria for the answer which were not available initially, the second question should be coded as a 2A, or whatever else it might happen to be. The fact that the teacher had to rephrase to get the desired answer indicates that the answering student accepted the open question as open and provided an "open" answer.

2- If a teacher follows the answer to a cognitive-memory (2A and 2B) or a convergent-production (3A, 3B, and 3C) question with an agree/disagree redirect question, give the redirected question the same code as the preceding question. Since both cognitive-memory and convergent-production questions have best or correct answers, both options for an agree/disagree redirect are not equally acceptable. The previous answer which the student to whom the redirect has been given is expected to evaluate is either correct or it is not correct; in choosing between agree and disagree, the student is essentially answering the original question.

3- If a teacher asks more than one question in succession without either allowing a student to answer or answering themselves, code only that question which the student answers. This will usually be the last question, but not always. An exception to this rule is the coding of several managerial questions. For example,

"Bobby, would you please sit down? Keith, do you think we can hold a discussion while you and Sandra are talking like that? LeeRoy, what are you doing to Patrice's dress? Susan, would

you please go to the office and ask Mr. Price to come down here for a few minutes?"

should be coded as a series of four 1's. 1, ", ", !!!!

4- As implied by the last sentence above, when a teacher asks the same question several times in succession, a more efficient way to code this is to write the code for the question the first time when it is asked, then to follow the initial code with a ditto mark (") each time the question is asked consecutively thereafter. A common strategy called ELICITING often employs the same question several times in succession and if the coder uses ditto marks to indicate that the same question has been asked several times in succession, this strategy will appear more obviously on the finished code-sheet.

5- Sometimes, tasks or problems which the students are expected to do to produce an answer are not phrased in the interrogative form. This is especially true for 3A type questions and for classification questions in general. Even if the interrogative form is not used, directions to a student to do something to produce an answer or solution should be coded as a question for the purposes of this category system.

6- Quite often in listening to audiotapes (less often in listening to "live" classes), not all the words spoken by the teacher are understandable due to technical and/or student problems. When questions are not understandable, code them with a lower case "o".

7- Many teachers sometimes phrase questions so poorly that understanding exactly what the question is getting at is difficult even though the coder can clearly understand the individual words that are spoken (an example is: "Ralphie, what about planets?"). Questions that are so poorly phrased that their intent is lost should be coded with a lower case "o".

8- There may be several kinds of questions which are perfectly understandable and for which the intent is quite clear but which are just not classifiable into one of the categories of this system. Whenever this type of question occurs, code it with a lower case "o".

9- To summarize rules 6, 7, and 8--any time a teacher verbalization that is obviously a question cannot be coded, use a lower case "o" to indicate that a non-codable question was asked.

WRITTEN PROGRAMMED INSTRUCTION

frame 1

You are about to read programmed instruction designed to help you learn to use the category system you have just finished reading. This program should not be read like a book because choosing different answers to the questions contained herein will sometimes ask you to turn to different pages of the program.

When asked to answer a question, please do so before turning to the page designated as the next one in the sequence. You will often be asked to write your answers down before proceeding to either the next page in the program or to a certain page in the answer key booklet. Unless you are possessed of an unusually good memory, you should follow these directions; not following them will likely insure that you will have to proceed through more pages of the program in the long run. Writing the answer when so instructed will get you through the program successfully faster than not writing them.

PLEASE TURN TO PAGE 3

frame 2

The directions on page (1) asked you to turn to page (3). Since you are reading this message, you obviously did not follow the instructions. Please turn to page 1.

frame 3

Below are several groups of classroom questions which should be coded as category 1. Please read these quetions and write down the common attributes you feel these questions have which might effect their being included together in a single category.

(a) "Has everyone here tasted salt?"
(b) "Did ya'll hear what Kevin said?"
(c) "Don't you think we should use a thermometer to measure the change in temperature?"
(d) "Now would the air be heated or cooled by lightning? If would be heated, of course!"
(e) "Who hasn't given me their data yet?"
(f) "Bobby, did anyone give you permission to talk?"

After you have written down the attribute(s) you feel these questions may have in common, turn to page 5.

frame 4

Keeping in mind the discussion you have just read on page 5 and also remembering the name of category 1--MANAGERIAL-RHETORICAL, please study the category 1 questions listed below and identify why each is coded as category 1.

(a) "What did you say?"
(b) "Does anyone need to have that repeated?"
(c) "Don't the tropics have more hot water than cold?"
(d) "But you can see that it happened, can't you?"
(e) "Does everybody's data look like this?"
(f) "Sandra, would you please turn around and stop pestering Harold?"
(g) Now why do you think the solution turned blue? Because we added a base to the solution.
(h) "Don't you really think that abortion is murder?"

PLEASE TURN TO PAGE 7

frame 5

All those questions have in common that the students don't really have to think very much at all to answer them and often are not expected to answer them at all. They are procedural, managerial, rhetorical, or use interrogative mode for phrasing a point of view with which the students are expected to agree. Students are expected to confirm something, to agree with the teacher, to take some action such as turning around and being quiet, or to give the teacher managerial information which the teacher can use in pacing and/or structuring a lesson.

If your answer was similar to the above, please turn to page 6. If your answer was very much different from the above or if you did not write down an answer, please turn to page 4.

frame 6

You have an adequate understanding of category 1--MANAGERIAL-RHETORICAL questions. Now you need to practice identifying questions which may or may not be coded as 1's. Below are three questions which you should code as either "1" or "Not-1" on a separate sheet of paper.

(a) "Connie, do you have something to say?"
(b) "What part of a meter would a decimeter be?"
(c) "Would you repeat your answer so everyone can hear it, Charles?"

After coding the three questions above as "1" or "not-1", please turn to page 9

frame 7

Categoryl questions are managerial, procedural, disciplinary, and/or rhetorical in nature. They do not normally deal with subject matter as such and when they do, they are rhetorical (the teacher answers them), they are factual statements made in interrogative mode with which the students are expect to agree, or more rarely that are requests for the student to reveal his or her state of understanding before proceeding to ask that student to answer another type of question.

PLEASE TURN TO PAGE 5

frame 8

You have received no instruction to turn to this page. Please re-read the page you just read and follow the directions carefully. If you cannot remember which page you were just on, return to page one and quickly follow the directions from page to page until you return to the page you just read.

frame 9

(a) This is probably a 1, but you would need to hear it in context to be sure of your categorization. If the teacher is using it to elicit an answer to a question which has been previously directed to another student, you would code this as whatever the original question was. Most likely it would be a 1.
(b) This is definitely not a 1! The student is expected to draw on his or her store of knowledge relating to the metric system and answer the question.
(c) This is certainly a 1.

If you missed either (b) or (c), please turn to page 4. If you did not miss either of these, turn to page 10.

frame 10

Below is a transcript of a short audiotaped science lesson. The questions to be coded are preceded by lower case letters in parentheses. Code each of these quetions as "1" or as "other".

T: (a) Is this a fruit or a vegetable?
MANY STUDENT REPLY--UNINTELLIGIBLE
T: (b) Are you sure?
MANY STUDENTS REPLY--UNINTELLIGIBLE
T: (c) What do you think it is Bonnie?
S1: A vegetable.
T. (d) Cathy?
S2: I don't know.
S3: I didn't hear you Cathy. (e) Would you speak a little louder?
T: (f) Yes, speak a little louder so that can hear you in the back of the room.
S2: I DON'T KNOW!!
S4: Aw come on. You know it's a vegetable. (g) They put 'em in salads don't they?
T: O.K. Robert, they put tomatoes in salads. That's quite true. (h) Do you know what a Waldorf salad is?
S4: Yes.
T: (i) What is in a Waldorf salad, Robert?
S4: Carrots and apples and raisins and stuff.
T: (WRITING ON BOARD) Robert said that this stuff is in a Waldorf salad. (j) Are there any fruits in that list of stuff, Joe?

After writing you codes for these questions designated above, please turn to page 13.

frame 11

Below is a transcript similar to the one you just coded. Code the questions preceded by lower case letters in parentheses as either 1 or other and write your coding on a separate sheet of paper.

T: (a) Joan, what do you see now?
S1: The water's muddy.
T: (b) Why do you think it is muddy?
S1: Because you just put some dirt in it and it hasn't had time to sink to the bottom.
T: O.K., the dirt hasn't sunk to the bottom yet. (c) Right? (d) Do you agree with that explanation, Jimmy?
S2: No.
T: (e) No? (LONG PAUSE)
S2: No, I don't agree. I don't think all the dirt will sink to the bottom. I think some of the dirt has dissolved in the water.
T: HMMMMM. That certainly an interesting idea. (f) How could you tell the difference between Joan's idea and Jimmy's idea, Sean? (g) How could you tell which of the explanations is correct?
S3: (h) Huh?
T: (i) Did you hear what they said?
S3: No, Ma'am.
T: (j) Why didn't you hear them? (k) Weren't you listening? (l) Were you daydreaming again? (m) Joan, would you please repeat what you said for Sean?

After writing down your analysis of this transcript on another sheet of paper, please turn to page 12 to check your analysis.

frame 12

-12-

(a) This is Not a 1 -- teacher is asking students to make a simple observation which is 2B.
(b) Other -- hypothesis formation is usually coded as 4C
(c) 1 -- teacher restates student's answer and asks her to confirm restatements's accuracy
(d) Other -- Student is being asked to evaluate another student's answer and both agree and disagree are equally acceptable. Therefore, this would be a 5A.
(e) 1 -- same as question(c)
(f) Other -- teacher asked two questions in rapid succession. Since the student did not answer either of them in an intelligible fashion, there is no way this can be categorized. Code it with an "o".
(g)
(h) This is a student question and should receive no code at all, not even an o.
(i) 1
(j), (k), (l), and (m) -- Since this is a string of managerial questions, they should all be coded. Your code sheet should designate them as a series of 1's.

If you did not understand the explanations given above, please return to page 11 and re-examine the questions in light of the explanations. If you do understand the explanations above and/or if you didn't miss any codes, please proceed to page 14.

frame 13

-13-

(a) The students are being asked to classify a tomato either as a vegetable or as a fruit according to their own criteria. This would be a 4B, NOT a 1. *

(b) 1 -- students are not really expected to provide an answer to this.

(c), (d) OTHER -- these are both 4B questions just like question (a).

(e) Student questions are NOT CODED using this system.

(f) This is not a question. It should not have been coded.

(g) Student questions should not be coded.

(h) 1 -- This is a relatively rare form of managerial questions. The student is asked to tell the teacher whether he actually has the knowledge to answer the next question before the teacher asks him the next question. The acceptance of the "yes" answer is a context clue.

(k) OTHER -- Since this is a memory-recall question, it is coded as 2A.

(j) OTHER -- students learn very early in life that an apple is a fruit. This would be an identification by label type of question, 2A.

If you coded the student questions as 1's do not count them as misses since they would have been 1/s had the teacher asked them. Please remember that the category system is meant to be used with <u>teacher questions only</u>.

After being given the student questions, if you missed more than one of the questions (i.e., if you miscoded more than one "1" as "other") please turn to page 11.

If you missed only one or if you missed none, turn to page 14.

*It might also be a 2A since most kids have learned to associate "tomato" with "vegetable".

frame 14

-14-

Below are several questions. Please read them and write down the attributes you feel they have in common. The questions below are all 2A questions.

(a) "How do you spell turquoise, Harold?"
(b) "What's the name of this mineral I'm holding up, Yolanda?"
(c) "What are the two different kinds of energy, Albert?"
(d) "O.K. Gene, is the chromate ion yellow, or is it red?"
(e) "Yesterday, we talked about cell membranes and you should have read the chapter on cells last night. What are cell membranes made up of Bob?"

After writing down the attributes you feel these questions have in common, please turn to page 15.

frame 15

-15-

All these questions require memory of previously learned materials or identification of something using a previously learned name. In both cases, the student is expected to provide a correct answer that has been previously learned.

Questions of this type are coded 2A -- cognitive-memory questions, level A.

PLEASE TURN TO PAGE 16

frame 16

-16-

Below are several questions. Please identify those that are 2A (memory-recall and identification with learned terminology) and those that are not.

(a) "What do you call rivers that look like this?"
(b) "Do you think it will float or sink?"
(c) "Can you tell me anything else about that?"
(d) "What's a liter, Bill?"
(e) "How many miligrams are in a gram, Ethel?"

After writing down the letters corresponding to those questions which should be coded as 2A, please turn to page 18.

frame 17

-17-

Category 2A questions are strictly memory-recall and identification using learned terminology. They are very popular with teachers of all subjects and are quite common to science lessons.

Whenever a teacher asks a student to recite previously learned materials, definitions, formulae, theories, proper terminology, etc., etc., the students are expected to answer using words and ideas they have studied and/or memorized. Examples of this type of question are:

(a) "What is the name of this?"
(b) "And what do you call that one there?"
(c) "Harold, what is the valence for the Ferrous ion?"
(d) "What formula describes the angular momentum of a rotating disk, Julio?"
(e) "Please tell us the three most important contributions made to the science of geology by Lyell, Marita?"
(f) "Would you please name the phyla from the lowest to the highest, Linda?"
(g) "What is the principle of uniformity, John?"

PLEASE TURN TO PAGE 19

frame 18

-18-

(a) 2A -- the teacher is asking for a learned adjective such as "meandering." Only if the context makes it very clear that a divergent response is acceptable should this be coded as something besides a 2A.

(b) Other -- If the teacher is asking for an inference from data, this is a 3B. If a prediction from an inadequate experience base is being asked for, this is a 4B. The context would provide sufficient clues for distinguishing between them.

(c) Other --To code this question properly, you need to know what the previous question was. Without that information, this question would have to be coded an o since it doesn't fit into the category system on its own characteristics.

(d) 2A -- the student is asked to recall a definition.

(e) Other -- this is a procedural question, category 1!!

(f) 2A -- Again the student is being asked to recall a learned fact. A possible exception to this coding might occur if context indicates that the metric prefix system has just been introduced. Under those circumstances, this might be coded as a 3A -- reasoning or working a problem with learned or given method to produce the right answer.

If you missed more than one question, please turn to page 17. If you missed only one or none, turn to the next page.

frame 19

-19-

Please read the questions below and write on a separate sheet of paper the attributes you feel they share which allow them to be placed together in category 2B.

(a) "What do you see happening, Sally?"
(b) "Ellen, what does the water look like?"
(c) "Would you say that again using your own words instead of the book's definition?"
(d) "What do you mean by that? Would you say it in a different way?"

After writing down the common attributes shares by these questions, please turn to page 20.

frame 20

-20-

The common attribute shared by these four questions is that the students are being asked to explain or describe something in their <u>own</u> words. In some cases they may be requested to translate technical terms into everyday language. OBSERVATION and TRANSLATION are the key words in describing this category. Questions of this type belong to category <u>2B</u>.

frame 21

-21-

If you missed the category 1 questions, please turn to page 5 and follow the directions from there.

If you missed the 2A and/or 2B questions, please turn to page 26.

frame 22

-22-

Below are several questions. Please code them as 1, 2A, 2B, and "Other". If you feel that you can correctly identify the category system code for some other questions included in the "Other," please feel free to do so because the actual coding for all questions will be listed and discussed in the key. However, please concentrate on properly coding the first three categories since those should be of primary concern at this point in the program.

(a) "Have ya'll seen a picture of what a membrane looks like?"
(b) What are proteins composed of, Sue?"
(c) "Does anyone have a question?"
(d) "What kind of energy is kinetic energy?"
(e) "How would you describe a fruit to me if I had never seen one, Marie?"
(f) "Why is the hot water staying at the top instead of going to the bottom, Jefferson?"
(g) "What do you call this long skinny thing I'm holding up. . . uh, Ben?"
(h) "What happened when you put on an extra washer. . .someone from group 4?"
(i) "If you pass this streak of lightning through the air and the lightning is hot and the air is cold, what is it going to do to the air around it? What's going to happen to the air, Roger?"
(j) "Why do you suppose the minerals we just listed on the board are worth a lot of money, Sandy?"
(k) "O.K., energy is the capacity to do work. Would you explain that in your own words?"

After coding the questions above as 1, 2A, 2A, and "Other" on a separate sheet of paper, please turn to page 23.

frame 23

-23-

(a) 1 -- this is a procedural question
(b) 2A -- memory-recall
(c) 1 -- another procedural question
(d) 2A -- memory-recall
(e) Other -- student is being asked to generate own classification system for distinguishing between fruits and vegetables. Therefore, this is a 4B.
(f) Other -- student is being asked to formulate a hypothesis so this is a 4C.
(g) 2A --identification of something by a previously learned name.
(h) 2B -- observation described using student's own words.
(i) Prediction -- either 4B or 2B, depending on context.
(j) Other -- Student is being asked to generate criteria for classifying minerals into valuable and not valuable groups, therefore, this is 4B.
(k) 2B -- student is being asked to translate a learned definition into own words.

If you missed more than one classification into 1, 2A, 2B, and Other please turn to page 21. Ignore any misses you may have had in trying to distinguish between the "Other" types of questions as long as you did not code the "other" questions as 1, 2A, or 2B.

If you missed only one or none, please turn to page 24.

frame 24

-24-

Below and on the following page is a transcript, derived from an audiotaped physical science lesson. Please code the questions preceded by lower case letters in parentheses as 1, 2A, 2B, and other. Write your coding analysis down on a separate sheet of paper.

T: (a) What about kinetic energy? . . .(b) What kind of energy is that, Bruce?
S1: (c) Is that the energy of moving objects? The energy of motion?
T: (d) Is that what you think it is?
S1: I guess so.
T: (e) Do you agree with him, Erin?
S2: Yes, I think that's right. At least that's what you told us yesterday.
T: (f) What causes heat? (g) Why does the movement of molecules cause heat? LONG SILENCE
T: (h) Lonnie?
S3: Sir?
T: (i) Why does the movement of molecules cause heat?
S3: I don't know.
LONG SILENCE
S3: Well, maybe it's because the molecules or whatever they are kinda rub up against each other and. . . .
(Laughter by other students make the rest of this answer unintelligible)
S3: (j) Well, if ya'll are so smart, why didn't any of you raise your hands to answer.

frame 25

-25-

T: (k) O.K., would ya'll please be quiet and let him finish answering the question? It sounded like a pretty good answer to me. . . .Go ahead, Lonnie.
S3: Well, I mean. . .you know. . .(PAUSE). . .like when you rub your hands together and they get warm, and when you fall down and slide across the gym floor, you get burned. . .Uh, maybe the molecules are making heat by rubbing up against each other.
S4: Yeah, you get hot when you rub up against your girl friend too.
(GENERAL LAUGHTER)

T: Actually, that's a real good explanation, Lonnie. Eric is jealous because he didn't think of it. Let's write in on the board. . .(1) O.K., Eric, can you think of another explanation?
(LONG SILENCE)
S4: Nossir.
T: (m) Well, do you think you should make fun of other people's answers, then?
S4: Well, it just sounded funny, you know?
T: I guess he could have said "rubbed together" instead of "rubbed up against." (n) Would that have made his answer a little less funny, do you suppose?
S4: Yeah, I guess so.
T: O.K. (o) Can you think of another explanation, Sherri?

After coding these questions as 1, 2A, 2B, or Other, turn to page 1 of the Key Booklet to check you answers.

---

frame 26

-26-

Category 2 is entitled COGNITIVE-MEMORY QUESTIONS.
There are two different levels in this category.
Level A includes memory-recall and identification questions. Any time a student is requested to recite previously learned material or to name something using previously learned terminology, the question should be coded 2A.

When a student is asked to describe something in his or her own words, or to translate previously learned materials into his or her own words a code of 2B is appropriate. 2B questions also include those questions which ask students to rephrase a previously made statement or answer.

PLEASE TURN TO THE NEXT PAGE.

---

frame 27

-27-

Below are several questions. Please code these as 1, 2A, 2B, and other. You may code the "other" category questions using the appropriate system code designation if you wish since these will be listed and discussed. However, please concentrate on separating category 1, 2A, and 2B questions from each other and from other categories.

(a) "Has anyone in here seen halite?"
(b) "What does classification mean, Margaret?"
(c) "What's an example of something that will dissolve in water, Danny?"
(d) "What's the difference between potential energy and kinetic energy, Kevin?"
(e) "O.K., Avogadro's number is the number of molecules in one mole of any substance. Can you tell me in your own words what a 'mole' is?"
(f) "Why do you think there would be a fat layer in cell membranes? Can you think of a function the fat layer might serve?
(g) "What happened when you put the permanganate crystal in the water, Janice?"
(h) "O.K., the lens. . . .Now, what is <u>this</u> part of a microscope, Roosevelt?"

After you have written the codes for these questions on a separate sheet of paper, please turn to the next page to check your answers.

frame 28

-28-

(a) 1
(b) 2A -- Both questions in the series are really asking the same thing so both are the same type of question. You really don't need the student's answer to code these questions.
(c) Other -- many acceptable answers to this, so it is coded 4A.
(d) 2A -- While this might be some other category in context, usually words like "the difference" and technical terms such as "kinetic" are keys that the student has already been exposed (like smallpox or measles) to the answer.
(e) 2B -- translation of a technical term (mole) into student's own words
(f) Other -- Had the student answered the first question, a code of 4C --hypothesis formation--would have been appropriate. If the student had answered the second question, a code of 4A would be appropriate. A context clue to the acceptability of several different answers is the use of "a function" instead of "the function."
(g) 2B -- student is asked to report observations.
(h) 2A -- student is asked to identify something using a previously learned name.

PLEASE TURN TO PAGE 22

frame 29

-29-

The next category in the classification system is called the CONVERGENT-PRODUCTION QUESTION category. Except for cognitive-memory and managerial-rhetorical questions, convergent-production questions are the most popular kinds of questions asked in science classes.

Convergent-production questions have in common that the student is expected to use some sort of reasoning and logic to produce a correct or best answer. The answer to a convergent-production question can be described as a logical necessity rather than merely a logical possibility. One answer to a convergent-production questions is demonstrably more right THAN other possible answers. The answers for this type of question may be objectively judged using a set of criteria which were developed prior to the asking of the question; usually the criteria for judgment the correctness of an answer to a convergent-production question have been established by "experts" rather than by either the teacher or the student.

PLEASE TURN TO PAGE 30

frame 30

-30-

The first level of convergent-production questions includes those questions which ask students to use a previously learned or given logical method or sequence of reasoning for producing the correct answer to the question. Learning formulas and methods of manipulating them and learning certain classification systems are examples of learning a logical method or sequence of reasoning designed to produce correct answers to certain kinds of questions. Examples of 3A questions are:

> "Chauncy, using the formula PV = nRT, can you tell us what the pressure will be in a previously evacuated 5 liter flask if we add 2 moles of carbon dioxide at 29°C.?"
>
> "A pair of blue-eyed/brown-eyed hybrid humans marry and have 8 children. If brown eyes is a dominant trait, how many blue eyed children would you expect them to have, Melvin?"
>
> "Using the characteristics for the various phyla of worms written on that handout sheet, separate the different kinds of worms at your lab bench according to the phyla they belong to."

PLEASE WRITE A 3A QUESTION YOU MIGHT USE IN YOUR TEACHING.

then

turn to page 31 please.

frame 31

-31-

Please identify the 3A questions below. On a separate sheet of paper, list only the numbers of the 3A questions.

(1) "Now, we added 4.00 grams of NaOH to 100 ml. of distilled water and added one drop of phenolphthalein. How many ml. of 0.01M. HCl should we add to this solution in order to get it to change colors from pink to colorless without actually making it acidic, Eric?"

(2) "Manfred, would you please derive the mathematical expression which described the relationship between the length and diameter of a solid rod and its angular momentum when it is spun around a point at its center of gravity?

(3) "What size resistor must you put into a circuit to allow only three amps of current to pass through at 1000 volts?"

(4) "O.K., at each lab table, there are several different types of plants. Now the question I want you to answer with those plants is this: What kind of a system, what set of criteria or characteristics, can you look at to use in separating those plants into only three groups such that the plants in any one group possess the characteristics of that group but the other plants do not possess those characteristics?"

(5) "Mario, here's a box of rocks. Would you look at them and tell us which one's are igneous and which ones are sedimentary, please?"

Write down the numbers of the questions you think should be coded 3A. Then turn to page 32.

frame 32

-32-

Questions (1), (3) and (5) are all 3A. Questions (2) and (4) are not. If you were correct on all counts, congratulations because some of them were pretty tricky. If you missed one or more, see the discussion below. If you have just been congratulated, please turn to page 35.

If you identified question (2) or (4) as a 3A question, please turn to page 33.

If you failed to identify questions (1), (3) and/or (5) as 3A questions, please turn to page 34.

If you made both kinds of errors, turn to page 33 first and follow the directions from there.

frame 33

-33-

(2) A question like this would almost certainly be a 2A, although it could be a 3C for an especially advanced group of kinds. The derivation in questions requires a fair knowledge of calculus (which indicates how important it is for a coder to have knowledge of the subject matter field being taught) and this is beyond most high school students (or most college students for that matter) unless they have learned a step-by-step derivation which they can memorize and reproduce or regurgitate on demand. Since this is most likely a memorized derivation which the student is being requested to give, the question would probably be coded as a 2A.

(4) The students are being asked to classify plants but they are being asked to generate the classification system which they will use. Therefore this is a 4B question.

If you also missed questions (1), (3) and/or (5), turn to page 34.

If you correctly coded those three questions as 3A, turn to page 35.

frame 34

-34-

Questions (1) and (3) are obviously "plug-into-the-formula-and-crank-out-the-answer" type questions. Questions of this nature are always coded as 3A.

Question (5) is not a "formula" type of question in the sense of manipulating numbers but it <u>is</u> a "plug-in" type of question in the sense that the student is expected to use a previously learned system of classification scheme to answer the question. The words "igneous" and "sedimentary" are context clues indicating that the system has been previously given and/or learned rather than student generated (students don't generally generate words like "igneous" and "sedimentary").

If you missed question (1) and/or (3), please turn to page 29.

If you missed only question (5), turn to page 35 please.

frame 35

-35-

Below are several questions. Please code them as either 3A or OTHER on a separate sheet of paper.

(a) "Why do you think the universe is expanding, Bob?"
(b) "How many grams of NaCl would you get by evaporating all the water from 500 ml. of a 2.00 M. solution?"
(c) "What formula should you use for calculating the acceleration due to gravity working on a freely falling body, Clarence?"
(d) "What is the major function of the cell's nucleus, Hank?"
(e) "O.K., Jeanette has given us several characteristics which she feels can be used to distinguish fruits and vegetables. Mollie, using Jeanette's characteristics, can you tell us whether squash is a fruit or a vegetable?"
(f) "Does your data look like the data that's already written on the board?"
(g) "How many calories are required to raise the temporature of 10 grams of water from 50°C. to 80°C., Sammy?"

(h) "Kitty, would you take this note to Miss Bradshaw please?"
(i) "Suppose the Arabs start another oil boycott and we have developed enough oil to supply ourselves and one other industrial nation? Who should we give our oil to, Imelda?"
(j) "What are some ways we might be able to use the cloning technique we have just been talking about?"

On a separate sheet of paper, code these questions as 3A or other. Then turn to page 36 to check your coding.

---

frame 36

-36-

(a) Other --Asking for a hypothesis. 2A if the hypothesis has been previously learned, 4C if it has not been previously learned. Context should provide sufficient clues for distinguishing between the two and if it does not, you would automatically code with a lower number--2A.
(b) 3A
(c) 2A -- student is being asked merely to remember the formula, not use it
(d) Other -- This is a 2A question ("the major function . .").
(e) 3A -- The student is being asked to classify using a given system which was developed by someone other than themselves.
(f) Other -- This is probably a 1 although you would need to hear it in context to be certain.
(g) 3A
(h) Other -- 1 (procedural)
(i) Other -- This is a forced choice kind of evaluation so this would be coded as a 4A.
(j) Other -- Since this is a completely open question, this would be coded as 4A.

If you mised more than 1, please turn to page 37. If you missed one or none, turn to page 40.

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frame 37

-37-

Category 3A questions are those which ask students to produce certain correct answers by using learned or given sequences of reasoning, logical systems, etc., such as mathematical formulae, systems of classification, or a series of logical "steps" which are associated with a successful way to produce the right answer. They are "plug-in-the-numbers-and-crank-out-the-answer" type questions and "properly-apply-the-learned-steps-or-criteria" type of questions.

Close your eyes, and in your own words, describe the attributes of 3A questions.

THEN, PLEASE TURN TO PAGE 38

frame 38

-38-

Below you will find five questions. Please identify these as 1, 2A, 2B, 3A, and other. Write your coding down on a separate sheet of paper.

(a) "What will the products be if you mix HCl and NaOH, Billy?"
(b) "Why does the sunrise occur later each day during the Autumn, Jessie?"
(c) "Can you name a way in which the structure of frogs is adapted to life as an amphibian, Sue Ellen?"
(d) "O.K., which of the compounds listed on the board are acids and which are bases, Gerry?"
(e) "If we had kept on heating the beaker until almost all the water had boiled away instead of just for four or five minutes after the water had started boiling, what do you think the temperature would have been, Lisa?"

After you have written down your classification of the above questions on a separate sheet of paper, turn to page 39 to check your answers.

frame 39

-39-

(a) This question could be either 3A or 2A depending on the context. If they have studied the actual reaction, it would be 2A-- memory-recall. If they are using a reasoning sequence such as (i) bases and acids react to form water and a salt; (ii) take H from the acid and OH from the base to make the water; (iii) stick what's left together to make the salt; then the question should be coded 3A since they would be using a learned sequence to produce the right answer.

(b) Other -- The student is being asked to propose a theory to explain certain observations so this should be a 4C. Again context is important since almost anything <u>can</u> be and often is memory-recall.

(c) Other -- this question has many acceptable answers so it is 4A.

(d) 3A -- student is being asked to use a learned classification system.

(e) Other -- this question is asking for an inference from data so it should be a 3B.

frame 40

-40-

Below is a transcript of an audiotaped physical science lesson. Please classify the questions proceded by a lower case letter as 1, 2A, 2B, and 3A. Code other types of questions as other or, if you choose, try to code them with the proper category codes since the other codes will be listed and discussed.

T: Allright, today we're going to talk about the metric system. (a) Irving, would you tell us what you know about the metric system, please?
S1: Well, I just know what was in that handout you gave us. . . you know, about the ruler in Paris and that other stuff. . . (PAUSE). . .Oh yeah, I went shopping with Mana yesterday and I noticed that a lot of cans and stuff were listing the weight in grams too. That's the metric system isn't it?
T: It certainly is. That's pretty observant Irving. (b) Why were you reading can labels?
S1: I always read the labels to see who's trying to trick us into paying more money for less stuff.
T: That's a pretty good idea. Ya'll should probably all do that whenever you go shopping. . .In fact, I think I'll make that an assignment (WRITING ON BOARD) All of you go to the grocery store some time this week and find at least one kind of thing thatlists the weight in grams. Then figure out how much it costs for a gram in two different size cans or packages. . . O.K., back to the metric system. (c) What's a measure of length in the metric system, Tina?
S2: The meter?
T: Right. (d) How about volume, Sam?
S3: I don't know.
T: Harvey?
S4: The cc.

PLEASE TURN TO THE NEXT PAGE

frame 41

-41-

T: Well, that's certainly one metric system volume measure. (f) What does cc mean?
S4: Cubic centimeter.
T: Right. (g) Do you know another metric system measurement for volume, Harve?
S4: Sure. The ml.
T. O.K., and Irving said earlier that the metric measure for mass was the gram.
S4: (h) How about kilos? They're a metric measure of mass.
T: That's a good question, Harvey. (i) What does kilo mean.
S4: That's what you use to measure how much a brick of dope weighs.
T: (j) Susan, do you agree with that?
S5: That's not what was on that handout sheet you gave us.
T: (k) Well, have you ever heard of marijuana being measured in kilos, Samantha?
S6: Yes, but they really mean kilograms. You know. . . a thousand grams.
T: (l) Can you think of anything else that has kilo in it, Arthur?
S7: A kilometer?
T: Right, that's a real good example. (m) How many meters are in a kilometer, Harvey?
S4: Golly gee whiz. I don't know. Could it possibly be a thousand?
T: Right, kilo is a prefix which means a thousand of whatever it is that follows the prefix. (n) How many kiloliters would you have with 2000 liters, Roger?
S8: (LONG PAUSE) Two?
S4: HOORAY and T: Right (Simultaneously)
T: (a) Harve, would you please refrain from making comments like that? They're very impolite and I don't want them in my class. (p) Do you understand?
S4: Yes ma'am, I sure do.
T: Good (LONG PAUSE, WRITING ON BOARD) O.K., I've written all the prefixes and what they mean on the board and they're also in that handout you go yesterday. (q) Robin, how many centimeters are there in a meter?
S9: 2.54?
T: (r) What does centi mean, Robin?

TURN TO THE NEXT PAGE

frame 42

-42-

S9: One-one hundredth?
T: Right. That means that a centi-meter is only one one hundredth as big as a meter. (s) If a centi-meter is only one one hundredth as big as a meter, how many centimeters would it take to make up a length as long as one meter?
S9: LONG PAUSE I don't know Miss Delgado. I can't do it.
S4: It's easy. You're just STUPID!!
T: Harvey. I've had enough of that. Anyone you put down in my class for being dumb, you're in charge of tutoring for the next quiz. Right now you're going to get the same score Robin gets on the metric system quiz. You get whatever she does so you better help her learn what she needs to know. If she flunks, you flunk. If you put down somebody else I'll add them to the list and get your grade by averaging their scores.
S4: That 's not FAIR!!! I already know this stuff and I can make a hundred on any test you give. It's not fair to give me a grade somebody else makes.
T: (t) Do you really think I'm trying to be fair?
S4: (INAUDIBLE)
T: What I'm trying to do Harve is to get you to stop putting down people in my class. You shouldn't call them stupid just because they don't know something that you do know. I'm also trying to help them learn some of that stuff you claim to already know. For shooting off your mouth, you get to help me if you want to make a good grade. (LONG PAUSE) (u) Now, Robin, how many centimeters will it take to be just as long as a meter if one centimeter is only one-one hundredth as long as a meter?
LONG PAUSE
T: You can't get it right if you don't try.
S9: (LONG PAUSE) A hundred?
T: Right. That's real good.

After writing down your analysis,
PLEASE TURN TO PAGE 2 OF THE KEY BOOKLET.

frame 43

-43-

The questions below are coded 3B -- a new category. Please read them carefully and write down on a separate sheet of paper the characteristics you feel they have in common which allows them to be placed in the same category.

(a) "Arabella, from looking at this data, how high in the tube do you think the alcohol will be if we raise the temperature of the water to 25° instead of to 20° or 30°?"
(b) "O.K., we've just talked about the effects of these different things on the movement of a piston. Now, Louis, what would happen to a balloon if it were blown up and tied off and then the pressure outside the balloon were to be increased?"
(c) "Let's see now. . .You got -7°, 17°, 47°, 78° and 105° for the boiling points of your amines besides getting a snoot full when you stuck your head in the hood. What do you think the boiling point of hexylamine will be if this trend continues, Cathy?"
(d) "You just tested for the hardness of talc and of quartz. Using these observations, what can you say about how hard obsidian will be, Johnny Lee?"

After writing down the common characteristics on a separate sheet of paper, please turn to page 44.

frame 44

-44-

All of these 3B questions deal with inferences, either from data derived in the lab, from a similar situation which has been observed and/or discussed, from principles and theories studied in class and so forth. Included in this category are questions which require the students to know what inferences cannot be made from data as well (e.g., one can't really infer the hardness of obsidian from the hardness of talc and quartz).

PLEASE TURN TO PAGE 45

frame 45

-45-

Another type of question which approaches inference-making from a different direction is the type of question which asks a student to list the reasons for giving a certain answer or making a given assertion. Related to this type of question and also coded 3B are questions which ask students to cite data and/or observations to support an answer or assertion. Questions which ask for the basis for making an aswer or statement are coded 3B.

If you have arrived at this page via pages 58 and/or 59, re-read the definition above and then return to page 58, following the directions thereon.

If you turned to this page from page 44, turn to the next page to continue the program.

frame 46

-46-

Below are listed five questions. One or more of these questions are not 3B questions. Identify the one or ones which are not 3B and write the identification down on a separate sheet of paper.

(a) "Why do you think it will get clear, Kenny?"
(b) "Dolores, if we did an experiment like this using alcohol instead of water, what do you think the graph would look like? How would it be shaped?"
(c) Why does the warm air rise to the tope of the room and the cold air settle to the bottom, Joe?"
(d) "Why do you believe in legalized marijuana, Harvey?"
(e) "You missed Tuesday's measurement? What do you think it would have been from looking at the other data?"

After writing down the identity of the non3B questions, turn to page 47 to check your answer(s).

---

frame 47

-47-

(a) 3B -- Kenny has already answered another question and is being asked for reasons to support his answer.
(b) 3B -- inferring from a known situation to an unknown one which is quite similar
(c) Other -- hypothesis proposition is usually coded as 4C
(d) 3B -- student being asked to list reasons for making a previous statement.
(e) 3B -- student being asked to interpolate from data.

If you correctly identified the question that was not 3B, please turn to the next page. If you said that any of the other four questions were not 3B, please turn to page 43.

---

frame 48

-48-

If you teach primarily earth science, turn to page 49.

If you teach primarily life science or biology, turn to page 50.

If you teach primarily chemistry, turn to page 51.

If you teach mostly physics or physical science, turn to page 52.

frame 49

-49-

You are an earth science teacher and your students have just completed an experiment dealing with the differential sedimentation rates of different sized sand grains. On a separate sheet of paper, write two <u>different</u> 3B questions which you might conceivably use during a post-lab discussion of the experimental results.

After writing the two different questions on a separate sheet of paper, please turn to page 53.

frame 50

-50-

You are a life science teacher. Your students have just completed an experiment dealing with effects of different concentrations of phosphate on the growth of algae. On a separate sheet of paper, write two <u>different</u> 3B questions you might ask during a post-lab discussion of this experiment.

After writing these two different 3B questions on a separate sheet of paper, please turn to page 54.

---

frame 51

-51-

You are a chemistry teacher. Your pupils have just completed an experiment dealing with the factors which affect the rate of the iodine clock reaction. On a separate sheet of paper, write two <u>different</u> 3B questions which you might ask in a post-lab discussion.

After writing these two different 3B questions on a separate sheet of paper, please turn to page 55.

---

frame 52

-52-

You are a physical science teacher and your pupils have just completed an experiment dealing with the factors which affect the period of a pendulum. On a separate sheet of paper, write two <u>different</u> 3B questions you might use during a post-lab discussion.

After writing these two different 3B questions on a separate sheet of paper, please turn to page 56.

---

frame 53

-53-

You're still an earth science teacher. This time, your students have completed an experiment during which they melted sodium thiosulfate crystals and then resolidified them by cooling the melts at different rates. On a separate sheet of paper, write two different 3B questions (preferably different in type from the two you wrote before) which you might use in a post-lab activity.

After writing these questions, please turn to page 57.

---

frame 54

-54-

You are now a biology teacher. Your pupils have just completed a field trip activity during which they collected several samples of water and identified the microflora and microfauna therein. The samples of water were collected every thirty yards along an Austin creek which serves to channel the effluent from a sewage treatment plant. The sampling was begun sixty yards upstream from the effluent pipe leading from the sewage treatment plant into your creek. Please write down on a separate sheet of paper two different 3B questions (preferably different in type from the two you just wrote) which you might use in a field trip debriefing discussion.

When you have written these questions, turn to page 57 please.

frame 55

-55-

You are still a chemistry teacher. Your students have just completed an exercise in which they added several drops of 0.01 M. $AgNO_3$ and 0.01 M. $Pb(NO_3)_2$ to a wide variety of 0.01 M. solutions of IA and IIA halides, nitrates, and acetates. On a separate sheet of paper, write two different 3B questions (preferably different in type from the 3B questions you just finished writing) which you might use in a post-lab discussion.

After writing these questions, turn to page 57 please.

frame 56

-56-

You are now a physics teacher and your students have just completed an experiment dealing with the boiling point of a variety of solvents including water, all at reduced pressure (you discovered a McCloud gauge hidden in the stockroom which allows your students to accurately measure the internal pressure created by pumping out the air in a glassware system at various rates). Please write two 3B questions (preferably different in type from the two you just wrote) which you might use during a post-lab discussion.

After writing these questions, please turn to page 57.

frame 57

-57-

You have just written four type 3B questions. All four of these questions should deal in some way with inference from data, observations, and/or principles. Some possible types of questions might include:

(a) The prediction of a clearly established trend.
(b) Interpolation of gaps in existing data.
(c) Distinguishing between conclusions, consequences and/or predictions which are and which are not supported by the data.
(d) Identification of information that is needed to change the status of a conclusion, consequence, or prediction which is neither supported nor refuted by the data to the status of supported or refuted (NOTE: This is not the same thing as designing a way to to get the information.)
(e) Prediction of consequences or results in a situation which is obviously similar to one which has just been recently studied, discussed, and/or experienced.
(f) Citing of reasons and/or data to support a conclusion, prediction or assertion.

If all four of your questions were like this, turn to page 58.

If any of your questions asked students to describe observations or results, turn to page 19.

If any of your questions asked your students to work a problem using a formula, classification system, etc., and the experimental data and observations, please turn to page 30.

If any of your questions asked students to propose a hypothesis to explain the data and observations, turn to page 46.

---

frame 58

-58-

Another type of question not directly related to the type of question you have just written are also coded as 3B. Write down the characteristics of this type of question on a separate sheet of paper. If you don't remember what these characteristics are then turn to page 45.

After you have written these characteristics, turn to page 59.

---

frame 59

-59-

Any time a teacher asks a student to list the reasons for giving a particular answer or for making a certain statement, to cite data or observations in support of a point of view, to justify an opinion or evaluation with the reasons and/or data used to reach that opinion or evaluation, the questions should be coded as a 3B.

"Why did you say. . . .?"
"What makes you think. . .?"
"Can you cite any evidence to support. . .?"
"Why don't (or do) you agree with. . .?"

are all keys to the beginning of this type of 3B question.

If your characterization was incomplete or incorrect, please turn to page 45.

---

frame 60

-60-

Below are 10 questions. Please identify them as 3B or "Other." Write your code down on a separate sheet of paper.

(a) "A watermelon, huh? Why do you say that, Karen?"
(b) "What kind of motion does the graph show -- constant velocity, acceleration, or deceleration, Lowell?"
(c) "What do you think about Bobby's method of solving the problem, Marilyn?"
(d) "How many centiliters are in a milliliter, Scott?"
(e) "How did you know that was going to happen, Tracy?"
(f) "Does everyone understand what Cathy is saying?"
(g) "Do you agree with that, Paula"
(h) "Why do you agree with that, Paula?"
(i) "John, what's happening now? What do you see?"
(j) "Is there anything wrong with that last row I just wrote on the board? Is there any data that looks as if it doesn't fit in with the rest of it?

After you have coded these questions as either 3B or "Other," on a separate sheet of paper, turn to the next page please.

frame 61

-61-

(a) 3B -- Student asked to give reasons for answer or statement.
(b) 3B -- student is being asked to interpret a graph so this is probably 3B. If the teacher has previously asked a number of 2A questions, one might suspect that this is a recognition type of question where they see the graph shape and automatically associate the shape with a learned response such as "deceleration."
(c) Other -- This is an evaluation question: 5B.
(d) Other -- This is a reasoning with a learned sequence: 3A.
(e) 3B -- Student asked to give reasons for believing previous assertion.
(f) Other -- 1
(g) Other -- Coding depends on context. If student is evaluating answer to a cognitive-memory (2 A,B) or convergent-production question (3 A,B,C) this would be given the same code. Otherwise, it would be a 5A if both agree and disagree options are equally acceptable as a response.
(h) 3B
(i) Other -- 2B: student being asked to describe what he sees.
(j) 3B -- they are being asked to infer from the data which individual datum doesn't look like the rest of the data.

If you missed more than two questions, discard the piece of paper on which you wrote your answers and turn to page 58.
If you missed two or fewer, turn to page 62.

frame 62

-62-

Below is a transcript of a physical science post-lab discussion. Please code the questions preceded by a lower case letter in parentheses as either 1, 2A, 2B, 3A, 3B, or "other." Feel free to attempt separating the "other" questions into the proper categories as well, since these will be listed and discussed. Concentrate on the codes you have already worked with in this program, however. Please write your coding on a separate sheet of paper.

T: (a) Keelie, what do you see about these eight sets of data that looks the same?
S1: They all use numbers?
T: O.K. That's one similarity but that's not exactly what I had in mind. (b) Marcie, do you see anything about those sets of data that looks the same besides the fact that they all use numbers?
S2: (LONG PAUSE) Gosh that's a hard questions Mr. Edelmeier. (c) Wouldn't it be easier to see if we graphed them so we could kind of look at them as pictures? You know, like we did with the other experiment, with colored chalk and stu
T: That's an excellent idea but we don't have enough board space to graph all of them. (d) How could we solve that technical problem, Jackie?
S3: Put 'em all on one graph but use the colored chalk so that each one is a different color just like you did in class Monday.
T: Great idea! (PAUSE) (e) Andy, what should we have along the X-axis?
S4: Time?
T: Andy says to put time on the X-axis. (f) Is that O.K. with everybody? (SHORT PAUSE) T-I-M-E (writing on board) (g) Rosy, how many units do we need?
S5: (Counts out loud from one to twenty) We made twenty measurements so we need twenty units.

PLEASE TURN TO THE NEXT PAGE

frame 63

-63-

T: Right! You're getting to be a real expert at setting up graphs, Rosy. (PAUSE) Uh. . .(h) James, how big should those units be?
S6: Er uh lemme see. . .We took the temperature every 30 seconds so every time unit should be 30 seconds bigger than the time unit before it.
T: Right! Right! That's real good, James. (i) Darcell, what are we going to put along the Y-axis?
S7: Temperature.
T: O.K., temperature. (j) Betsy, do you agree with that?
S8: Yessir, that's right.
T: (k) Why do you think that's right?
S8: Because temperature is the only other thing we measured!
T: O.K., just checking. That's real good Darcell. . .Now, I want each group to send one person to the board to graph that groups data. Be sure to use a different color of chalk from the other group.
(General confusion reigns for about ten minutes)
T: All right Calm Down!!!. . .Danny, you and Imelda turn around and pay attention. Judy, put your makeup back in your purse and pay attention to the board. Jackson sit down and be quiet. (SHORT PAUSE) O.K., that's better. Now Marcie, you suggested graphing the data. (l) Can you see anything about all those sets of data that look alike?
S2: (VERY LONG PAUSE) Well, . . .they're all shaped kinda alike. (Another VERY LONG PAUSE) I mean the graphs are. . . uh, the temperatures are. . .YOU know, the temperatures kind of go down real fast at first, then they go down real slow, then they all kind of go down real fast again. . .well, not real fast, but

PLEASE TURN TO THE NEXT PAGE

frame 64

-64-

faster than when they were going down real slow (another LONG PAUSE). That's the only thing I can see.

T: (m) Ruben, do you see another way the sets of data look all alike?

S9: Well, not all of 'em, but 4 of 'em are real close together, you know?. . .I mean, they start to go down real slow a whole lot sooner than the other four. And the other four are real close together too. I mean. . .well, they all start to go down real slow about the same time too. (LONG PAUSE) Do you want something else? (PAUSE) Well. . .uh. . .O.K., the two groups start to go down real slow at different temperatures.

T: Hey, that's pretty sharp. I wasn't even ready to ask that question. (n) Anne, why do you support four sets of data are very similar to each other but not to the other four sets?

S10: (PAUSE) Uh (LONG PAUSE) Well, uh (Another LONG PAUSE) Some of us used moth flakes and the rest of us used moth balls and we had to really grind out mothballs up while the people who had moth flakes just kinda poured 'em right into the test tube. You know, just like they were, without grinding them up. (LONG PAUSE) I mean, it's probably because some of us ground ours up real real good in the mortar and pestle and the others kind of used theirs real lumpy, You know?

T: That's a real good explanation. (o) How could you tell whether or not her explanation is right, Larry?

PLEASE TURN TO PAGE 3 OF THE KEY BOOKLET

frame 65

-65-

The next level of convergent-production questions are coded as 3C. These are the questions which require a student to produce a best or right answer to a problem or question, the right ness or bestness of which can be judged by objective criteria which have been previously established by someone other than the student who is answering the question. Again, the answers to questions of this type are logical necessities (or very high probabilities) rather than logical possibilities. Unlike the previous categories, however, the student has not learned the best or even a good way to go about producing the answer; the student has not learned a series of steps, formula, classification system, or whatever which is associated with getting a right answer to this kind of question. The student has to produce the method for getting to the right answer as well as the right answer itself.

Included in 3C category are many of the questions which would be classified as application and analysis questions in Bloom's TAXONOMY (other application questions might also be coded as 3A or 3B). Questions asking students to identify their underlying assumptions are included in category 3C (This is not the same as asking them them to give their reasons for presenting a certain answer or statement. This is asking the student to identify the assumptions, often unidentified, which must be true if his or her reasons, predictions, etc., really apply to the situation. One common assumption which underlies science is that the universe can be understood by humans. Another is that events can be predicted within certain probability ranges if one knows what the relevant antecedent events are. Both of these are probably true with a capital T, but they remain unproven assumptions.)

PLEASE TURN TO PAGE 66

frame 66

-66-

To this point in the program, the example questions have been derived from audiotapes of teachers conducting real science lessons in the public schools. This policy will be continued but this will insure that the section on 3C questions is quite short. The reason for this is because secondary science teachers as a group just don't ask very many 3C questions while they are conducting a lesson. Questions of this nature may appear on exams and quizzes but they do not appear very often during classroom interaction of any sort. Perhaps their phrasing is too difficult for spontaneous occurence in classroom discourse. If this is the case, teachers should probably plan to use them ahead of time if they feel that this type of question needs to be asked during some lesson which involves using questions. Perhaps many secondary science teachers feel that their students would not be able to answer this type of question and do not ask this type of question because they wish to protect their students from almost certain failure. If this is the case, perhaps they should at least ask their students to occasionally identify their assumptions which underlie the reasons behind their answers. The ability to do this (identify underlying assumptions) might transfer to other situations and be quite useful to the students in their life away from school and in their life in other classes. This is merely the opinion of the writer, however. End sermon. Restart Program. Please turn to page 67.

frame 67

-67-

Below are five questions. Please read them and code them as 1, 2A, 2B, 3A, 3B, 3C, and Other. Feel free to code the "other" questions as 4A, 4B, 4C, and 5B since these codes will be identified and discussed as well as the first 6. Please concentrate on the first six categories, however.

(a) "Who can tell me what it'll probably do?"
(b) "You said the temperature would remain the same if we kept boiling it, and I'm interested in why you said that. What do you have to assume to say that, Roger?"
(c) "Do you think abstinence is a good method of birth control, Sandra?"
(d) "Why not?"
(e) "O.K., imagine that you are a meteorologist and that you're giving a talk to some 6th graders about what you do for a living. What are some of the things you might tell them, Roxanne?"

After coding these questions on a separate sheet of paper, turn to page 68.

frame 68

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(a) 1 -- The teacher is not actually asking someone to predict. He or she is merely asking for a volunteer. If a volunteer give a prediction, score as 4B.
(b) 3C -- Identification of underlying assumptions is being requested.
(c) Other -- This is asking the student for an evaluation: 5B.
(d) 3B -- student is being asked for reasons behind a previous assertion (the assumptions underlie the reasons which in turn underlie the initial statement of an answer, opinion, etc.)
(e) Other -- There are many acceptable answers to this question so it can be considered a 4A.

PLEASE TURN TO THE NEXT PAGE

frame 69

-69-

Below are five questions. Two of them are 3C questions. Identify which ones these are.

(a) "Which of these plants -- the one's described by Sandra, Bobby, and Miguel -- would be best able to survive under the conditions I've listed over here, Martin?
(b) "Why do you think the period of the pendulum stayed the same even though you lifted the bob higher before you let it go, Judy?"
(c) "O.K., Sandra said the period of the pendulum would be shorter if the bob were heavier. How could we test to see if she's right, Micky?"
(d) "Allright, Micky said to add another washer to the string. Is that a good way to test Sandra's hypothesis, Harold?"
(e) Now that we have all the steps to the experiment written on the board, I'm gonna ask someone whether or not performing the experiment as it is now written up there will really answer the question, or whether there's something ya'll are still leaving out. Whichever one you decide, I'm going to want you to tell me why you decided that way. I'll give you a few seconds to think about it before I select my victim (LONG PAUSE) Anabella?"

PLEASE TURN TO PAGE 70

frame 70

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The 3C questions are (a) and (e). If you did not identify these questions as 3C, or if you identified one of the other questions as 3C, please turn to page 71.

If you correctly separated the 3C questions from those which were not 3C, please turn to page 72.

frame 71

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(a) This 3C question is one which might be classified as an ANALYTICAL question using Bloom's system. The wording implies that one of the plants is, in fact, better able to survive under the listed conditions. In order to produce the right answer (i.e., pick out which plant would survive) the student must compare a variety of each plant's characteristics with environmental demands which are pertinent.

(b) Coding this type of question depends on context, but questions asking for hypothesis formation are generally coded 4C. If the hypothesis has been previously studied, of course, the question would be coded 2A.

(c) There are usually several equally acceptable ways to test any hypothesis or prediction. For that reason, experimental design questions are usually coded 4B.

(d) This simple agree/disagree evaluation should be coded 5A (student says "yes, it is a good design" or "no, it's not a good design")

(e) This is an analysis question too. In this case, the student who answers the question correctly must have examined the question, analyzed the experiment design to determine if all factors are included and controlled, and then examined whether or not the observing technique is sufficiently sensitive to answer the question.

PLEASE TURN TO PAGE 65

frame 72

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Below is a transcript of a lesson on gas laws taught to a 9th grade physical science class. Please code the questions preceded by lower case letters in parentheses as 1, 2A, 2B, 3A, 3B, 3C, and "other." If you wish to code the "other" questions as 4A, 4B, 4C, 5A, and 5B, please do so since these codes will be listed and discussed as usual. Please remember that, when using this category system, you should attend only to the kinds of questions the teacher is asking. Not to other things that the teacher and/or students are doing.

T: Class, today we're going to talk about gas laws. (a) Can anyone tell me what a gas is? (MUCH NOISE AND CONFUSION) (b) Ardella, what's a gas?
S1: Yes ma'am. A gas is a state of matter that doesn't have no shape or volume.
T: That's about a good a definition as anyone could think of, I believe. (c) Can anyone give me an example of a gas, Robert?
S2: Fire Chief and Gulftane.
T: Uh. . .That's not the kind of gas I'm talking about, Robert. We're talking about the states of matter like solids, liquids, and gases. (d) What state of matter is a gasoline like Gulftane, Robert?
S2: I dunno. Depen's on how hot it is.
T: (e) Susan, what state of matter is gasoline?
S3: Isn't it a liquid?
S2: It ain't no liquid in the cylinder of my brother's short!!!
T: (f) Robert, would you please refrain from shouting out like that? O.K., now, I have a little apparatus set up here so we can experiment with gas laws.

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frame 73

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T: (g) Johnny Lee, what's this thing right here?
S4: That's a roun' bottom flask.
T: Right, Good (h) Mary, what's this?
S5: Rubber stopper.
T: (i) O.K., how many holes are in it?
S5: Mus' be three cause I can see three things sticking up out of it.
T: (j) How do you know that the number of things that are sticking up are the same as the number of holes?
S5: Cause I can see the bottom of it from where I'm setting and there ain't but three holes in the bottom.
T: O.K., Good. (k) Willie Jones, what are these three things sticking up?
S6: Well, one of 'em's a piece of glass with a balloon tied to it and one of em's a pencil, and I don't know what the other one is.
S2: (LOUD WHISPER) Tha's a stopcock, fool. Don't you know nothin'?
T: Robert! (PAUSE) O.K. That's a stopcock. Now, I'm going to blow into the stopcock. (l) What's going to happen to the balloon, David?
S7: It's gonna blow up.
T: O.K., David said that the balloon was going to blow up. (m) Do all of you agree with that prediction?
S2: It ain't gonna do nothin'.
T: You don't think it will blow up Robert? (n) Why NOT?
S2: Cause the stopcock's turned the wrong way. Anybody can see that. You just gonna get red in the face blowin' on it like it is.
T: You're right. I had it turned the wrong way. Thanks for warning me. (o) O.K., if I turn it this way, will the balloon blow up when I blow on it?

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frame 74

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S2: Yeah.
(PAUSE: Teacher is blowing up the balloon. Conversation of students chattering in background need not be transcribed for the purposes of this module.)
T: (p) Why did the balloon blow up, David?
S7: Because you blew your breath in it.
T: (q) Why did it stay blown up, Willie Jefferson?
S8: Cause you turned that thing and wouldn't let the air out.
T: (r) Do you think the balloon will go back down if I opened the stopcock?
S8: Uh-huh.
T: Let's try it. (PAUSE) You were right. That's good, Willie. Allright, I'm going to blow it up again and then we'll do another experiment. (LONG PAUSE, again with much non-pertinent background chatter.)
T: O.K., be quiet and listen everybody so you'll know what we're doing. Patrice, hush! Sam! You, too. (PAUSE) I've got a pan of ice water here. (s) What's going to happen if I put this ice water around the round bottom flask, Cornelius?
S9: Nothin', it's just gonna get cold.
T: O.K. (Writes on board). (t) Arthur, what do you think is going to happen to the balloon when I put the ice water around the bottom of the flask?
S10: I dunno.
T: Robert?
S2: That balloon is gonna get bigger.
T: (Writing on board) Robert says it will get bigger. (u) Why do you think it will get bigger, Robert?

PLEASE TURN TO THE NEXT EXCITING PAGE

frame 75

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S2: I don't THINK it's gonna get bigger. I KNOW it's gonna get bigger. (LONG PAUSE) When I push air into a small space like when I push down on my bicycle pump and hold the end closed real tight the pump gets real hot. Since it gets hot when you push it into a small space, it'll get bigger when you get it cold.

T: O.K., well, I'll just write the other possibility down too (Writes on board). Now, let's vote. How many think the balloon will get smaller? (PAUSE) Nobody? O.K, how many of you think it will stay the same? (PAUSE) Cornelius, did you change your mind? Allright, how many of you think Robert is right when he says it'll get bigger? (PAUSE) Well Robert, everyone thinks that you're right. Let's try it (LONG PAUSE) (v) Hmmmm. What's happening, Robert?

S2: It's gettin' smaller.

T: Well, you said it would get bigger, but it got smaller instead. (w) Why did that happen? Think back through your reasons and figure out what's wrong with them. Where did you miss in your thinking? Why did you think pushing on a bicycle pump was the same thing?

After you have coded these questions on a separate sheet of paper, turn to page 4 of the key booklet.

frame 76

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The next category of questions are divergent-production questions. One might say that this category of question invites the production of logical possibilities for answers rather than the production of answers which are logical necessities (Questions which require answers which are logical necessities would be classified as convergent-production or possibly as cognitive-memory). Like the convergent-production questions, there are three different types of divergent-production questions which are coded, strangely enough, 4A, 4B, and 4C. Below are listed several questions, some of which should be coded as 4A. Please try to identify the 4A question.

(a) "What would happen if they continued to move further and further apart, Herb?"
(b) "What is one example of a gas, Robert Earl?"
(c) "Why do you suppose the taller candle went out first, Cecille?"
(d) "What are some of the things that you can use to tell whether or not something is living or non-living, Rodney?"
(e) "Alvin, please tell us what temperature you got when you dissolved the alka-seltzer in the water."

After identifying which of these questions are 4A, please turn to the next page.

frame 77

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Questions (a) and (d) are 4A category questions.

If you missed either one of these, or if you coded another question as 4A also, turn to the next page. If you correctly separated these from the non-4A questions, skip to page 79.

frame 78

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Below are listed some 4A questions. Read them and write down the characteristics you think they have in common which allows them to be placed in the same category.

(a) "Name one kind of sedimentary rock Alvin?
(b) "What kinds of things would you like to study in science this week, Debbie?"
(c) "Camille, could you tell us one example of friction from everyday life?"
(d) "What kind of plants would you like to put in the terrarium, Joe?"

Please write the common characteristic(s) on a separate sheet of paper.

THEN, TURN TO THE NEXT PAGE PLEASE

frame 79

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4A questions are either completely open or may be answered with a wide range of factually correct answers. The student may use extended reasoning to produce an answer to a 4A question, but extended reasoning is not absolutely necessary for producing an acceptable answer. Students might even be able to draw on previously learned information to answer such a question so long as it is possible for several students to answer the question with a different answer and all of them be "right."

Below are five questions. Identify those that should not be coded as 4A.

(a) "Where could you find warm water in the ocean, Jerome?"
(b) "O.K., Mr. Wright, would you give us an example of pollution?"
(c) "What is one unit of measure in the metric system, Stanley?"
(d) "What are some of the things that you might find in oceans, Rafaella?"
(e) "Name an economically valuable mineral, Cleveland?"

After you have identified those questions which are not 4A, please turn to the next page.

frame 80

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All five of these questions should be coded as 4A. All of them are open questions which have many acceptable answers and do not require extended reasoning to produce an answer. Even a question such as "What is one unit of measure in the metric system, Stanely?" which can be answered by drawing on previously learned information is coded as 4A because there are many possible correct answers to the question. (No matter what Stanley replies, the teacher can direct the question to another student such that: "What's another unit of measure in the metric system?" and the second student to answer the question can give a different equally correct answer). If you coded one or more of these as Not-4A, write down in your own words the characteristics of 4A questions and then turn to page 81.

If you decided correctly that all the questions were 4A, please turn to page 82.

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frame 81

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The 4A questions are simple divergent questions which have many acceptable answers. Extended reasoning is not required for producing answers to 4A questions but may be used if the student chooses. These questions can be completely open such as "Elizabeth, what are some ways we might use this beaker?" or they may require a factual type of answer with many possible correct answers such as "What's one example of something that is not a metal, Luis?" Answers to 4A questions do not require extended reasoning to produce and there are many possible answers which are equally acceptable as responses to all 4A questions.

If your description of the characteristics of 4A questions was similar to the above, please turn to page 83. If your description was very much different from the above, please turn to page 76.

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frame 82

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4A questions are fairly simple, and they allow a very wide range of responses which can legitimately be considered acceptable, right, correct, or O.K.; a type of 4A question which is common to many science lessons is asking a student to name one example of a class of some specific group of organisms, chemicals, rocks, etc. Other types of 4A questions which commonly occur in science lessons are the type of question which teachers ask when they ask a student to propose some potential uses for a mineral, technique, piece of apparatus, new technology, and so forth. These are not the only 4A questions which can be asked in relation to teaching science but they are very common kinds of 4A science questions.

Write 3 4A questions which you could use in teaching your class. After you have written these questions, check them against the description above. If you feel your questions match that description, turn to page 84.

frame 83

-83-

You will now recode a lesson transcript which you coded earlier. This time, add 4A to the other categories which you are designating (1, 2A, 2B, 3A, 3B, 3C). Also use the "Other" category for questions which fall into categories you haven't yet studied ("Other" includes only four categories now; you're nearly through with the written part of this module).

Be sure that you follow the directions in the key booklet pertaining to recoding the transcript which begins on page 40. The directions following recoding are quite different from those which follow the initial coding.

PLEASE TURN TO THE TRANSCRIPT BEGINNING ON PAGE 40.

frame 84

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The next category, 4B, includes questions which require some extended reasoning to produce one of the many possible acceptable answers. Examples of types of 4B questions include: (i) questions which ask students to compare, contrast, or classify using criteria for classification and comparison which they themselves generate; (ii) questions which ask students to predict when they lack sufficient data to insure success or make success highly probably; (iii) questions which ask students to propose an experiment or a step in an experiment for answering a previously asked question (Note: if the teacher asks a student to propose a step for an experiment the student is expected to have read, outlined a procedure for, etc., the questions would be a 2A, NOT 4B; 4B questions are those which ask the student to design an experiment rather than use an experiment designed by someone else).

The key to each of these is that several different equally acceptable ways to answer exist even though some fairly stringent logical criteria may be applied in judging the answer. In context, the prediction from insufficient data is often used as a strategy to build interest in the outcome of a particular exercise and might even be used with experimental design questions during the same pre-lab period. Classification questions which can be coded as 4B are often used prior to the introduction of a more scholarly system ("Scholarly" means "in the textbook" usually), again to generate interest and develop process skills.

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frame 85

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Below is a short transcript of an 8th grade earth science class. Please read it and, where indicated, write down a 4B question which you would use in this situation.

T: Joe's ready to show us hisproject, so ya'll button up. . .Joe?
S1: This is a sand-squeeze box that shows how faulting works. All there is to it is a box with a glass front and a truck jack with a piece of wood the size of the interior of the box bolted to it. The jack and the piece of wood can act like a piston.
S2: What do you do with it?
S1: Well, you put in several layers of sand so that you can see the layers. Then you can crank the jack up to see what happens to the layers if you push on them. . .Or you can crank the jack down to see what happens to the layers when you release the pressure that's holding them where they are.
S2: What keeps the glass from breaking if you crank the jack up real high?
S1: It's safety glass. It won't break.
S2: Oh, O.K.
S3: What's faulting?
S4: How do you tell the layers apart if all you put in there is sand?
S1: You put cement or plaster of paris on top of each one of the layers so that it makes a grey line that you can see between each one of the layers.
S3: What's faulting, Joe?
S1: It's. . .Uh. . .I don't think I can explain that. Mr. Delarose, could you tell 'em what faulting is?
T: Well, we haven't studied that unit yet and it's not really part of this unit,

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frame 86

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T: (continued) but I guess there's no time like the present since you brought in such a neat project, Joe. . .Ronnie, you and Steve take those buckets and go outside to the sandpile to get enough sand to fill this box between a half and two-thirds full. Rosie, you go into the storeroom and look on that wall next to Mis Morgan's room on the third shelf from the bottom and bring that sack of plaster of paris that's already been opened and put in a plastic break bag.

(LONG BREAK while they set up the sand-squeeze box. Finally, it is set up with the strata clearly defined and visible from the back of the room and the jack in place ready to apply pressure either toward or away from the layers of sand. Pretend you are the teacher.)

T: _____?

Write down a 4B question to use at the point in the lesson indicated by the blank space above. After writing down the question, turn to the next page and compare your question to options that might be available.

frame 87

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A common type of 4B question written by teachers who have already completed this module is the type which asks for a prediction from insufficient data --i.e., most teachers would ask a student to predict what will happen, even though they haven't studied faulting yet. One such question submitted by someone who has already worked through the module was:

> "What's going to happen to those layers when I put pressure on them with the jack, Stanley?"

The teacher from whose lesson this transcript is derived asked a different kind of 4B question:

> "Can you think of another way we might set this up so that we could tell the difference between the layers, Camille?"

Both alternatives are acceptable; they both require some reasoning to produce good answers, but many answers which can be considered good are possible. Noone who has worked through the module so far has written a classification or comparison type of 4B question. If yours was like this, please write it below. Then turn to the next page.

frame 88

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continue with the transcript as on page 86.

T: Can you think of another way we might have set this up so we could tell the layers apart without using plaster of paris, Camille?

S4: (LONG PAUSE) You could use different colors of sand like the stuff they sell in the craft shop across the street at Dobie Center.

S5: That'd be too expensive, Camille! Look how much sand it takes to fill it up!

S4: We could dig up some dirt and use it for every other layer. That way every other layer would be a different color. Does it have to be sand, Joe, or can we use dirt?

S1: I guess it would work with dirt if the dirt were dry, but I'm not sure.

S6: Yeah. We could get some dirt from Bert's Dirts out by my house. Why don't we go on a field trip to Bert's dirts, Mr. Delarosa?

T: Well, if you live right out there, why don't you just stop by after school this afternoon and pick some up? If you do, we'll try it tomorrow. . .Now that was a pretty good idea and I'd like to try it out of someone'll bring in some dirt to make layers with. Right now, though, we've already got it set up another way. _____?

Write down another 4B question which you might use at this point in the lesson. Then turn to the next page.

frame 89

-29-

Again, the most common type of question proposed has been to ask for a prediction of what will happen. This is an excellent type of question, especially if the teacher plans to elicit predictions from many different students to get a wide variety of predictions.

Again, noone who has worked through the module to date has proposed a classification or comparison type of question. If you wrote such a question, please write it in the space below so we can use it when we revise the module.

The teacher who actually taught this lesson asked another experimental design type of question.

Please turn to the next page and continue with the transcript.

frame 90

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T: O.K., what do you want Joe to do, put pressure on the sand or relieve the pressure? Which way should he crank the jack?
(GENERAL PANDEMONIUM)
T: Let's vote. Everybody who wants to put more pressure on the sand, raise your hands. (COUNTING) Well, it looks like they want you to increase the pressure on the sand, Joe. I don't think there is any need to ask for a vote on the other alternative. WAIT! Not yet, Laura, what do you think will happen when he increases the pressure on the sand layers? (THE TEACHER WHO ACTUALLY TAUGHT THIS LESSON FINALLY GET AROUND TO ACKING A QUESTION LIKE THE ONE THAT HAS BEEN MOST POPULAR WITH TEACHERS WHO HAVE WORKED THROUGH THE MODULE)
S3: Well (LONG PAUSE) It's going to just kinda squunch up together (LONG PAUSE) I mean the layers are gonna get thicker than they are now. (PAUSE) Except for that, nothing is going to happen to them.
T: Fred?
S7: Well, I think she's right, except the layers are going to be a lot thicker at the end closest to the jack than they will be at the other end. (PAUSE) Do you want anything else?
T: That's O.K. (WRITING ON BOARD) So you and Laura say that it's gonna look like this after we put more pressure on the layers?

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frame 91

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S7: Make the layers thicker than that at the end by the jack and have them kind of curving up too. . .No, curving up toward the jack at that end.
T: (DRAWING ON BOARD) Like this?
S7: Yeah.
T: Is that allright with you Laura? Does that look like what you were trying to describe?
S3: Wellllll. . .I don't think it will curve up like that but the rest of it is O.K.
T: _____?

What kind of 4B question could you as the teacher ask at this point that could keep the lesson moving in the direction you wish it to go? Please turn to the next page to check your question with some of the available options.

frame 92

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So far, every teacher who has worked through the module prior to this edition has written a question designed to elicit another prediction such as:

"What do you think will harpen when we increase the pressure on the layers, Robert?"

The teacher who actually taught this lesson when it was recorded did not use a 4B question at all, although he easily could have. He used a 3B question.

"Fred, can you convince her that you are right? Why do you think it's going to curve up like that?

This is a 3B question because the student is being asked to list the reasons for making the prediction he made.

please turn to the next page

frame 93

-93-

After writing and discussing a large number of 4B questions, you should be able to identify them when they occur. You are now ready to examine category 4C. In the opinion of some teachers and other professional educators, 4C questions are what science education is all about. Included in this category are those questions which would be classified as SYNTHESIS by someone using Bloom's system. Also included are questions which ask students to propose a hypothesis which will account for certain observations, data, etc. (this is a type of synthesis question).

When coding 4C questions, context is especially important. The earlier questions asked by the teacher and the words and tone of voice the responding student uses are both important context cues for deciding whether or not the students have actually read about or been told about the hypothesis they are proposing. If they have studied the hypothesis previously, a question asking for the hypothesis would be coded as a 2A. The level of the students must also be considered, regardless of what has been studied (or rather, not studied) in a particular class. For example, many questions that would definitely be 4C for 9th grade physical science students would be 2A for college-bound seniors who are taking physics as an elective, no matter what the teacher has officially covered during the course prior to asking the question.

The most common type of 4C question heard in science classes is the type associated with asking for hypothesis formation.

PLEASE TURN TO THE NEXT PAGE

frame 94

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Below are several examples of 4C questions which, like other divergent-production questions, allow a wide variety of acceptable answers.

(a) Robert, I want you to go to board and, using nothing but inorganic chemicals to start with, make up a route to synthesize aspirin. The structure for aspirin is written over on the side board if you don't remember it.

(b) There are huge coal deposits near the North Pole in the Arctic Circle. Considering what you know about how coal was formed and both the temperature and the incident light at the North Pole, how can you explain the presence of coal deposits up there, Geneva?

(c) The water will hold only just so much salt and then it just won't hold any more. The extra salt just sinks to the bottom and will not dissolve. What kind of picture or analogy can you invent to show how water and salt act to act like that? What can you think of that you can see and fool around with that might exhibit similar properties so that you could say the water and salt are acting "as if" they were like that?

(d) "Why do you suppose the warm water stayed on the top instead of sinking to the bottom, Cynthia?

after carefully reading all the 4C questions above,

PLEASE TURN TO PAGE 95

frame 95

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Please categorize the questions below as 1, 2A, 2B, 3A, 3B, 3C, 4A, 4B, and 4C. Since the only other major category remaining for you to learn is the Evaluation category, code the "other" with a 5. If you wish to distinguish between 5A and 5B, feel free to do so. Write your codes on a separate sheet of paper please.

(a) "Wouldn't you have the same kinds of currents if you had hot and cold water in the ocean?"
(b) "Marvin just said that the densest water in the oceans comes from the North and South poles. How could we find out if this is true?"
(c) "What is salinity, Nancy?"
(d) "That thing I have projected on the wall represents a photograph of some fossil footprints that were found by some geologists in a layer of rock in Onion Creek. Mandy, very carefully describe just exactly what you see. Don't try to interpret the observations, just tell us exactly what you see."
(e) "Do you agree with tnat, Joe?"

After you have written your coding on a separate sheet of paper, turn to page 96.

frame 96

-96-

(a) 1 -- teacher is asking students to agree
(b) 4B -- experimental design question
(c) 2A -- memory-recall
(d) 2B -- simple observation
(e) depends on the context. See coding rules 1B and 2.

If you missed any of these, reread the question in light of the coding above. If you can't reconcile the question with the code above, please re-read the category description. After you have done this, code the questions below in a similar fashion.

(a) "Randy, suppose I give you a chemical analysis of the mica and quartz and it tells you that they both have the same chemical composition as far as the percentages of each kind of element are concerned. How can you account for the difference in their appearance?"
(b) O.K., all the data from Mendel's experiments is in that handout you just got. I know you haven't studied it yet so this should be real hard, but you can do it. Find a simple rule from that data which will allow us to predict what kind of offspring you will get when you breed two different kinds of peas.
(c) "James, what is this thing I'm holding up?"
(d) "How about the tropics, Sammy?"
(e) "Did you want to say something, David?"

After writing down the code for the five questions above, turn to the next page.

frame 97

-97-

(a) 4C -- hypothesis formation
(b) 3C -- production of a right answer without the logical system having been taught
(c) 2A -- recognition and labeling
(d) o -- this question cannot be coded out of context and possibly not <u>in</u> context
(e) 1

If you missed any of these, please turn back to page 96 and re-read the questions you missed in light of the category assignments above. After doing this, please turn to the next page and identify only those questions which should be coded 4C.

frame 98

-98-

Please identify those questions below which should be coded as 4C. Do not code questions which are not 4C unless you wish to do so as an additional exercise.

(a) "When you go out on the ocean, it looks flat all the way to the horizon. If the world is really round, why doesn't the surface of the ocean appear to curve away from you toward the horizon, Rubin?"

(b) One thing that any plants which eat insects have in common is that they evolved in areas where the soil was deficient in one or more nutrients. How can you explain why this is the case, Melanie?

(c) "Why does the temperature of water stay at 0°C. all during the time that it is freezing, Marianne?"

(d) "I've written the physical characteristics for compounds A, B, and C on the board. Over here are five possible structural formulae for the three compounds. Which of those structural formulas is not associated with any of the three compounds, Hugh?"

(e) "How do you explain what was reported in that TIME article, David? How could the fossils of land animals have been found in a core drilled from the bottom of the ocean fifty miles out from the nearest land?"

Please identify the questions which should be coded as 4C and write these identities on a separate sheet of paper before turning to the next page to check your coding.

frame 99

-99-

All the questions are 4C EXCEPT (d) which should be coded as 3C. This analysis question definitely has a correct or best answer.

If you correctly identified the 4C category questions, turn to the next page. If, however, you misidentified one or more of the five questions, please turn to page 98 and re-read the questions, considering the short discussion above. All of them except (d) are asking for hypothesis formation of one sort or another.

frame 100

-100-

You are now ready to resume your interaction with the transcript of an 8th grade earth science lesson which was begun earlier. Write the questions which you would use at a spot designated in the transcript. Unless otherwise specified, you should write ONLY 4C questions.

T: Does anyone else have an idea about what the sand might do? Ron?
S6: I don't think it's gonna do anything. That jack's not big enough and since it's a jack-in-the-box, if it were a big jack I'd eat it for lunch, hee hee hee (etc. as he giggles over his joke)
T: (WRITING ON BOARD) O.K., Ron, you said it wasn't going to change because the jack's not big enough. The layers of sand will stay the same. Right?. . .Any other ideas, Becky?
S10: Could it break into two pieces and one of 'em slide over the top of the other one?
S6: Naw man. That's SAND!! It's not gonna do THAT!!
T: I'm not sure I understand what you mean. Would you draw a picture of it on the board? A picture of what the layers will look like after we apply the extra pressure?
(Student draws picture of what it will indeed look like and then returns to seat)
T: _____

Please write a 4C question you could use in this situation. When you have written your question, turn to page 102 please.

frame 101

-101-

GO BACK TO PAGE 100. BE SURE TO WRITE YOUR QUESTIONS DOWN BEFORE TURNING TO THE DESIGNATED PAGE.

frame 102

-102-

Typical 4C questions appropriate to this point in the lesson are "Why do you think she guessed that would happen, Charlie?" and "How does that work, if it does that? If what she said were to happen, Ralph, how could you explain why it did that?"

Another common strategy which several teachers write down and identify as 3B, even though the directions specifically requested a 4C type question, is a question which requests that Becky tell WHY she predicted what she did. Apparently many teachers feel that this question would be most appropriate at this point in the lesson.

A third common strategy which could be used might be to ask still another different student to propose a different prediction. This kind of question would be coded as 4B.

If you thought of a synthesis type of 4C question, please write it in the space below so we may use it in revising the module.

PLEASE CONTINUE YOUR INTERACTION WITH THIS LESSON ON THE NEXT PAGE.

frame 103

-103-

T: That's real interesting, Becky. Would you like to tell us why you decided that's what would happen?
S10: No, I'll wait.
T: O.K., does anyone else have a different idea about what's going to happen when Joe turns the crank?
S2: I think it'll fold up into wrinkles. (PAUSE) You know, like a carpet does sometimes when you push on it. . .You know, like a carpet does when you try to push furniture across it and its not tacked down?
T: You think that the whole thing's gonna wrinkle across and fold up?
S2: Uh-huh.
T: O.K. (WRITING ON BOARD) We have five different pictures of what people think it'll look like. Does anyone have another idea? Does anyone think it'll be different from one of these pictures?
S11: Would you tell us what they are all about again?
T: Sure. The one here that Fred and Laura decided on said that the layers would get thicker and that they would be thicker toward the end near the jack than at the other end. Ron said it wouldn't change at all because the jack isn't big enough. Becky said it would break and one layer would slide over the other to give something that looks like this picture right here, with part of the layers higher than the other part. Rhonda said it would get all mixed up and there wouldn't be any layers left. Delma said the layers would fold and wrinkle and end up looking like this. . .Are there are any other usggestions?. . .Is that O.K.? Do you know what all these pictures represent?. . .O.K., let's do it.
S6: WAIT!! Let's vote! Let's vote!

PLEASE TURN TO THE NEXT PAGE

frame 104

-104-

S9: Aw come on, Ronnie, let's get through so we can study for our English test.
S6: No, I wanna vote.
T: O.K., How many of you agree with Fred and Laura (PAUSE) Six? (WRITES ON BOARD) How about Rhonda's picture? (PAUSE) Two? (WRITES) Allright, how many of you think it won't do anything like Ronnie said? (PAUSE) Only one. (WRITES) How many of you agree with Becky? That's this picture right here. (PAUSE) Three. (WRITES) Now how many of you think it'll fold and wrinkle like Delma said? (COUNTS) Thirteen! (WRITES) Wow! A lot of people agree with you Delma. You must have had a pretty good idea. That's just twenty-five. Who didn't vote? (PAUSE) Luis, which idea are you gonna vote for?
S12: I'll go along with Delma. She's a good chicano.
S6: Hey may, I'm a chicano too.
T: Well, I really don't think any of these pictures are chicano. they're just pictures. Anyway, that makes fourteen for your idea Delma. Joe, how did you vote?
S1: I voted for Becky's idea.
T: O.K., well let's crank it up and see what happens?
(THE DEMONSTRATION WORKS PERFECTLY, CREATING A CLASSIC MINIATURE THRUST FAULT JUST AS BECKY SAID IT WOULD, WITH A SLIGHT THICKENING NEAREST THE JACK)
T: _____?

Write a question you feel is appropriate to this point in the lesson. It may be any type of question you wish, but identify the type.

please turn to the next page

frame 105

-105-

Again, a number of options are possible and many different kinds of questions can be asked, depending on what direction the teacher wishes to take the class.

Many teachers choose to ask a 2B question at this point -- a simple observation such as "What happened, Delma?"
A second type of question would be to ask a student to match what happened with one of the pictures on the board. This would be a 3A question, since it is asking the student to classify the observation according to a given classification scheme (the set of pictures would be the classification criteria)
Another type of question might be to ask Becky why she predicted what so obviously just happened. Since this is asking a student to explain the reasons behind an answer or assertion, this would be a 3B question.
A fourth option would be to ask someone to propose a hypothesis explaining why what happened actually happened. This would be a 4C type question.
A fifth option would be to ask a procedural question: to ask everyone to draw a picture or diagram of the results, for example.
If the students had actually already studied faulting, many different kinds of 2A questions could be asked. In this case, the students had not studied faulting prior to the demonstration, so 2A questions would be inappropriate.

Did <u>your</u> question match the characteristics of the category you meant for it to? If not, write that type of question with the proper characteristics. Did you write a 4C question? If not write one for fun and practice. Then turn to page 106.

frame 106

-106-

Continue reading the transcript below. Be role-playing the teacher in your mind so that you can think of many alternative questions you might ask at various points in the lesson.

T: What happened, Edward? (THE TEACHER WHO ORIGINALLY TAUGHT THE LESSON WHEN IT WAS RECORDED USED A POPULAR STRATEGY -- A 2B QUESTION)

S13: Well, it looks kinda like a cross between what Fred and Laura said and what Becky said.

T: Then you're willing to say that the other predictions were not supported by the experiment?

S13: Yeah, I guess so.

T: Rhonda?

S8: Well, I was wrong. So what? It ain't the first time. And DELMA was wrong, too.

T: I don't think there's any need to take that kind of attitude. Anyway, I wanted to ask you a question, not point out that your prediction wasn't upheld by the experiment. Why do you think it worked like that? Can you see anything that might help you to figure out why it did that? You can get up and come up here to look at it closely if you think that'll help you answer the question. Why did it do that instead of one of the other things that was predicted?

S8: (LONG PAUSE) I can't think of a reason. Ask Becky, it was HER idea!

T: Good idea. Becky, why did you think it would do that?

S10: I don't know why it works like that.

T: How did you know to predict that, then, if you have no idea how it works?

S10: I was over at Joe's last night when he finished building it and we tried it. It worked like that.

PLEASE TURN TO THE NEXT PAGE

frame 107

-107-

T: In other words, you weren't really making a prediction. You had already seen what would happen.
S10: Uh-huh.
T: O.K., Margarita, who had the closest prediction of those four people who had never seen it before?
S5: Fred and Laura, I guess.
T: O.K., Laura, it fattened up at one end just like you and Fred said it would, but it also broke and slid. Why do you suppose that happened? What kind of a theory or hypothesis can you make up to explain why it worked like that? Why do you suppose it broke and slid as well as fattening up and getting thicker at one end?
S3: Well, I guess (LONG PAUSE) Well, I REALLY thought it would ripple and fold like Delma said it would. I just wanted to vote for my idea because I wanted to be sure somebody voted for it. I don't have the SLIGHTEST idea why ANY of it happened at ALL
T: _____ ?????????

What wuestions could you ask at this point? Try to write down several uptions -- one each for the following types of questions: 4C, 4B, 2B, 3B, and 3C. Write down your questions before you turn to page 109.

frame 108

-108-

YOU RECEIVED NO DIRECTIONS TO TURN TO THIS PAGE. WORKING THROUGH THE MODULE GETS A LITTLE TEDIOUS AT TIMES BUT YOU SHOULD TRY TO FOLLOW THE DIRECTIONS IN YOU WANT TO GET MAXIMUM BENEFIT FROM IT.

Even if you're not sure at this point that you really do want to get maximum benefit from the module, please turn back to page 107 and follow the directions. There's not much left to the written part of the module. You're almost through with this portion.

frame 109

-109-

Please open the booklet which contains a short description of the category system and the rules for distinguishing between questions which are very much alike entitled: THE QUESTION CATEGORY SYSTEM--DESCRIPTION OF THE CATEGORIES AND CODING RULES.

Using the descriptions of the categories provided in this book, please check your five questions (2B, 3B, 3C, 4B, and 4C) to be certain that they possess the characteristics associated with those types of questions. If one or more of your questions did <u>not</u> match the group characteristics, please rewrite the question or write another different question which does match the characteristics.

After you have checked each of your questions with the appropriate description of category characteristics and assured yourself that you are sufficiently familiar with the five categories to write questions of each type, turn to page 110.

frame 110

-110-

Below you will find an extended transcript. Please code the questions preceded by numbers in parentehses as 1, 2A, 2B, 3A, 3B, 3C, 4A, and 5 (If you feel comfortable distinguishing between 5A and 5B, please do so.) Write your analysis down on a separate sheet of paper-- the transcript is rather long and you will not be able to remember the codes for all the questions without writing them down.

T: (1) Fred, can you convince her that you're right? Why did you think it would curve up like that?
S7: Well, the jack is not in the middle. It's gonna push harder against the bottom than it is the top. (PAUSE) That's gonna cause it to push like this. . . .See what I mean?
S1: The board is bolted to the top of the jack Fred. I don't think that's going to make any difference, because the pressure is applied pretty evenly all the way across.
S7: Oh. . .well in that case, she's probably right.
T: (Writing on Board). O.K., ya'll both think it's gonna look like this after he puts the pressure on. (2) Right?
S7 & 3: Yes & Uh-huh.
T: Rhonda, you're shaking your head back there. Do you think it might do something else besides that?
S8: Well. . .it might. . .Oh, that's O.K., I'll just agree with them.
T: O.K., so you say it's gonna look like this too (Writing on board).
S8: Wait, don't write <u>my</u> name up <u>there</u>!

PLEASE CONTINUE ON THE NEXT PAGE

frame 111

-111-

T: But you said you thought it was gonna look like this, just like Fred and Laura. You agreed with them.
S8: Well, write Fred and Laura's name up there too. It's really <u>their</u> idea.
T: (Writing on board). O.K., Fred and Laura and Rhonda all think that it's gonna look like this after Joe puts the pressure on with the jack. (LONG PAUSE)
S8: I <u>REALLY</u> think it's going to get jumbled up together in a big mess and you won't even be able to tell that there <u>are</u> any layers, so just erase <u>MY</u> name. (LONG PAUSE) The layers are goint to get all mixed <u>up</u>. There won't <u>BE</u> any more layers after he cranks that thing. (LONG PAUSE) Well, draw a picture of <u>THAT</u> andput <u>MY</u> name beside <u>IT</u>.
T: (Writing on board) (3) Like this?
S8: Yeah, that's O.K.
T: (4) What do you think is going to happen when he turns the crank, Roxanne? What are the layers of sand going to look like after he turns the crank and puts pressure on them?
S9: Sir?
T: I said (5) What do you think is going to happen when Joe turns the jack-crank and puts a lot of pressure on those layers of sand?
S9: Oh, I agree with what Rhonda said.
T: (6) What <u>DID</u> Rhonda say?
S9: Wellllllllll?. . . . . (LONG PAUSE)

PLEASE CONTINUE CODING THIS TRANSCRIPT ON THE NEXT PAGE

frame 112

-112-

T: Rhonda, don't tell her now. She should have been listening. Roxanne?
S9: I don't know. I was studying English.
T: Roxanne, don't study another subject in my class unless I give you permission. Rhonda, tell her what she agreed with while I write her name up here on the board next to yours. (LONG PAUSE while this is being done) (7) Roxanne, do you still agree with Rhonda now that you know what she said?
S9: Yessir, I guess so.
T: O.K., now pay attention for the remainder of the period. If we get through early, you can have some free time to study English. (8) O.K.? (9) Does anyone else have an idea that is different from these two? Ronnie?

After coding these questions on a separate sheet of paper, turn to page 6 of the key booklet to check your answers.

frame 113

-113-

The last category (HOORAY!!) is that of EVALUATION and there are two levels--A and B. The first is a simple type of evaluation question which asks a student to agree or disagree with a statement, point of view, etc., made by the teacher, another student, or some other source. Both choices must be viable options, equally acceptable as evaluations. This is why "evaluating" answers to 2A, 2B, 3A, 3 B, and 3C questions with an agree/disagree are really not considered as evaluations: because only one of the two choices is really acceptable or correct.

Below are five questions which should be coded 5A or other. Please code them on a separate sheet of paper.

(a) "Do you think Rodney's idea for doing the experiment will help us answer the question, Lisa?"
(b) "Robert Earl said the formula for Sodium was Ne. Do you agree with that, Celita?"
(c) "Cherise has proposed abstinence as a good way to stop the population explosion. Do you think she's right, Karen?"
(d) "Do you disagree with Patrice, George?"
(e) "Why do you think that abstinence isn't a good method for birth control, Karen?"

PLEASE TURN TO THE NEXT PAGE

frame 114

-114-

(a) 5A
(b) 2A -- this obviously follows a memory-recall question. The only correct response to this question is "Disagree".
(c) 5A
(d) ?? -- The context is necessary to identify this question. Without context clues such as what is being agreed or disagreed with, the question must be coded as o.
(e) 3B -- student is being asked to cite her reasons for evaluating the way she just has.

If you missed any of these, please reread the question in light of the coding and/or explanation provided above. If you still disagree with the coding, re-read the discussion of the specific category characteristics contained in the booklet describing the category system and coding rules.

After you are satisfied with the above coding of these five questions, please turn to the next page.

frame 115

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BELOW IS A DISCUSSION WHICH WAS RECORDED IN A SENIOR PHYSICS CLASS DURING THE SPRING OF 1973. Please code the teacher's questions with the categories you have learned through 5A. If you can, code the 5B questions appropriately as well. Write your analysis down on a separate sheet of paper.

S1: Well, I think that one of the main reasons why we did such terrible things in Viet Nam is because the scientists invented such terrible things like napalm and defoliants and other stuff like that. If it weren't for the things scientists have invented, we wouldn't have been able to do all that maiming and killing and stuff.

T: (a) Do you really believe that science is what caused the maiming and killing, Carl?

S1: (PAUSE) Well, not causes, no, but it makes killing a lot more efficient and painful. We practically killed off an entire race of people and. . .well, I guess. . .Uh. . .Well, genocide just wasn't possible like that until this century with all the wonderful scientific and technological advances.

T: (b) Do you agree with him, Debbie?

S2: Agree with what? He said a lot of different things.

T: O.K. Let's break it down. Let's take one point at a time. Carl, if I get what you are saying wrong, don't hesitate to break in and correct me. Now (writing on board) Point one -- Genocide wasn't possible until this centure. (c) Do you agree with that?

S2: No.

T: (d) Why not?

PLEASE TURN TO THE NEXT PAGE

frame 116

-116-

Physics class discussion of war, genocide and scientists' responsibility-- continued

S2: Anyone who has ever studied their Old Testament knows that the Assyrians carried off the 12 tribes and committed genocide on them. All the Jews today are descended from one tribe. The others were destroyed. That's genocide.

S1: O.K., I'll retract that statement. Countries have practiced genocide before this century. But we're a lot better at it because of our advanced science though.

T: Carl, you've mentioned genocide two or three times already. (e) Why do you think the U.S. Army in Viet Nam committed genocide? Do you have any evidence or observations to support that?

S1: Well, I kind of kept up with the body count every day for about a year. . .As a kind of game, you know?. . .anyway, if you compare the body count of the quote enemy unquote dead reported by the army every day with the population figures reported for the countries involved, you get the idea that we killed nearly all the people. That's genocide and we did it with out bombs and stuff.

T: Oh I see (PAUSE) (f) Do you think that logic is O.K., Nan?

S3: Nossir. . .In the first place, the army's estimate of the enemy killed was probably inflated a little bit. I mean they lied about everything else, so why not casualty figures?. . . In the second place, the population wouldn't be static. It would be increasing at an exponential rate, especially in Southeast Asia, and any killing would have to slow down the, uh, the rate of increase of the population growth before genocide began.

PLEASE TURN TO THE NEXT PAGE TO CONTINUE READING

frame 117

-117-

T: (g) Carl, would you like to respond to the points Nan made?
S1: Well, she's probably right about the army lying. I mean if they hadn't been consistently lying about the casualty figures . . .if we'd have really killed that many of them we'd have won the war instead of getting beat like we did. (PAUSE) Well, she's probably right about the population growth too. I mean what she says makes a lot of sense. (LONG PAUSE) O.K., I'll retract that statement too. We really didn't kill off the Indochinese yellow peril. (LONG PAUSE) But I still think that science is a great force for evil!!!
T: O.K., we're back to what got the whole thing started in the first place. (h) Do you agree with him, Laureen? Do you feel that science is a great force for evil in the world?
S4: Well (LONG PAUSE) scientists invented napalm and that's evil especially when they use it on people. . . .
S1: WHAT ELSE IS IT EVER USED ON?
S4: Carlton, hush up and don't interrupt me. You been talkin' <u>all</u> mornin' !!! Now, where was I before I was so <u>RUDELY</u> interrupted.(PAUSE) Oh yeah. . . But scientists invented penicillin too and that's helped to save a lotta lives. (PAUSE) And besides <u>that</u>, if it weren't for the scientists, you wouldn't have no electric guitar to play Carl. You wouldn't be able to play so loud it hurt everybody's ears.

After you have coded the teachers questions on a separate sheet of paper, turn to page 7 in the key booklet.

frame 118

-118-

The last category is 5B: More complex evaluation. Below are several evaluation questions. Please read them:

(a) "In terms of how well the question will be answered once the data has been collected, which of these three experiments is the best one, Lee?"
(b) "Imagine that you're marooned on a desert island with two of the people in the class and you know that you won't be rescued for six months. If you wanted to survive for those six months, who would you choose to be the two persons from this class to be marooned with, Monica?"
(c) "O.K., you're a judge and, essentially, the problem is this: If you find in favor of the pollution control board and make the chemical plant shut down until they can design a method for adequately treating their wastes, 800 people will lose their jobs. There's a good chance that the chemical plant will never re-open in that community which depends on it as the largest employer in town. If you find in favor of the chemical company and grant them an extra amount of time which they have requested for developing a way to treat their waste, the lake into which they must dump that waste will certainly die. Which way would you decide this case, Johnny?"
(d) "What do you think is the worst pollution problem in Austin, Sandra?"
(e) "Which of these experiments would you rather do, Ruby?"

After reading the questions above, you should be able to identify 5B questions. Write down their characteristics in your own words before turning to the next page.

frame 119

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In order for a question to be categorized as 5B, the student should be required to evaluate and choose at a more complex level than simply agreeing or disagreeing with what someone else has already said. The criteria for evaluation may be internal or external but a choice from among alternatives, a ranking of alternatives, or a rating of the desirability and/or value of some alternative as opposed to other alternatives (not always verbalized) should be required for answering 5B questions.

PLEASE TURN TO THE NEXT PAGE

frame 120

-120-

YOU HAVE FINISHED THE WRITTEN PART OF THIS MODULE AND SHOULD BE READY AND ABLE TO ACCURATELY CODE TRANSCRIPTS USING THE QUESTION CATEGORY CLASSIFICATION SYSTEM. PLEASE TAKE THE BOOKLET TITLED: written program exit assessment AND CODE THE FIRST TRANSCRIPT.

WRITTEN PROGRAM EXIT ASSESSMENT

You have completed the written program component of the module and you are now ready for your final examination in categorizing questions in written transcripts. Your criterion goal for categorizing written questions is 80% accuracy.

Below, and on the next several pages, is a transcript of an audiotaped chemistry lesson. The students are college bound sophomores, juniors and seniors. To set the stage, the teacher has walked in swirling a liquid in an erlenmeyer flask. When the teacher shakes the liquid, it turns blue; when the liquid is allowed to remain undisturbed for a few seconds, it turns back colorless.

S1: What's that stuff in the flask?
T: Well, that's a pretty good question, Phillip. (1) What do you see?
S1: Some liquid that turns blue when you shake it, then turns back clear again.
T: O.K. (2) Is there anything else in the flask. . .uh. . .Kent?
S2: I don't know. I can't see it over here.
T: Oh! O.K. Ya'll pass this back to Kent. Be careful not to drop it or take the stopper out or anything like that. Kent, you can shake it and everything but be sure to hold the stopper in. (LONG PAUSE)
S2: Well, the bottom of the stopper is in the bottle.
T: O.K. (3) Anything else, Mary?
S3: Naw. (LONG PAUSE) (4) Is there anything else in the liquid? . . .I mean, it's not just one thing is it?
T: That's a real good question. No, it has KOH, glucose, and methylene blue dissolved in water. I'll write down the structures for these two on the board. While I'm doing that, pass the flask around and see if you can figure out how it changes colors. Just be careful to hold the stopper on when you shake it.
(MUCH HUBBUB, CONFUSION, TALKING , CHALK SCRATCHING ON BOARD, ETC.)
T: O.K., Pipe down!!. . .(5) Has everybody had a chance to look at this stuff or play with it? Derwood? Somebody pass the flask over to Derwood. (PAUSE) O.K. (6) Does anyone want to hazard a guess as t'how it works? (PAUSE) Diane?
S4: I want to ask a question.
T: O.K.
S4: (7) Is there anything on the stopper?
T: (8) What do you mean? I'm not sure I understand exactly what you're asking.
S4: Well, when you shake it up, the solution touches the stopper and I was just wondering if maybe there wasn't some sort of chemical

or something on the stopper that made the solution change color. Then when the solution falls back into the bottle, it's not touching the stopper anymore and it might change back to the original color, that is if there is anything on the stopper I mean. (LONG PAUSE) Well, is that how it works?

T: Hmmmmm. (9) How would you test to see if her hypothesis is a viable one, Dusty?

S5: I just KNEW you were gonna ask me that!!! (PAUSE) We could get a different stopper and try again.

S6: He might have put chemical on all the stoppers!

T: (10) Do you really think I'd be that sneaky?

(CHORUS OF YEAH, SURE, OF COURSE, YOU SURE WOULD, ETC., ETC.)

T: O.K. (11) What could you to do insure against my chicanery, Barbara?

S7: Your what?

T: Chicanery. That means trickery.

S7: Oh. . . .Well, we could wash off the new stopper.

S6: The chemical might not be water soluble!!!

T: Aw come on Allen! Surely you don't think I'd go to that much trouble. (12) Why do you think the chemical if on the stopper--if there is one -- might not be water soluble?

S6: Well. . .uh. . .it just might not be, and we ought to be sure.

T: (13) If there is a chemical on the stopper, what observation might indicate that it's not water soluble. . .uh. . .David?

S8: I dunno. (LONG PAUSE) Well, I really don't. If I did, I'd TELL you.

T: O.K.. . .(14) Wanda?

S9: I didn't understand the question.

T: Diane said that the reason the stuff changes colors when you shake it is because there's a chemical on the stopper that one of the chemicals in the solution reacts with to turn blue. Then she says something else in the water makes the blue stuff turn back colorless when it's not hitting the chemical on the stopper, anymore. Allen says that the chemical on the stopper, if there is one, might not be soluble in water. (15) Do you know what soluble means? (PAUSE) O.K. then, the question is this: (16) What OBSERVATION might support Allen's hypothesis that the chemical on the stopper would not be soluble in water?

S9: What observation?. . .I don't think there is one. . .(PAUSE) Can I look at it again? (LONG PAUSE) Well. . .uh. . .(LONG PAUSE) OH SURE! If the stuff on the stopper would dissolve in water, it would dissolve when you shook the flask and would stay in the solution after that. It wouldn't ever turn back to colorless because all the stuff on the stopper would dissolve in the water just like the other stuff--the glucose and KOH and that other stuff. It HAS to be insoluble in water.

S7: We could wash off a different stopper with some of that stuff that smells like glue or with gasoline. That would take care of it.

T: O.K., Barbara says to wash off a different stopper with some non-aqueous solvents like acetone and gasoline. (17) Is that O.K., Allen? Would that take care of the problem?

S6: Use benzene too.

S10: And ether!! Use ether too!

T: O.K. Allen says to use benzene and Lamar says to use ether, so we'll wash off the new stopper with acetone, gasoline, benzene and ether. (18) Do you think we should do anything else to the new stopper uh. . .Tanya?

S11: No, that's enough.

T: (19) Giselle, how about you?

S12: You might soak it in acid for a few seconds.

T: (20) Why acid, why not base?

S12: If a base would react with it, I guess KOH in the solution would have already reacted with it. And acid eats up a lot of different things too.

T: Hey, hey! That's pretty sharp thinking! (21) What kind of acid could we use, Katherine?

S13: A lot of different ones. HCl, H_2SO_4, HNO_3, HOAc. (PAUSE) Those are some acids.

T: (22) Derwood, can you think of some more acids we might use?

S14: Which one's did she say?

T: That's a very good question Derwood. (23) Which one's <u>did</u> she say?

S14: Uh. . .I wasn't listening.

T: You should listen Derwood. You'd be amazed at the results you will have. She said hydrochloric, sulfuric, nitric and acetic acids. Now (24) what are some other possibilities?

S14: Uh. . .hydrofluoric acid?

T: O.K., that's a good one. (25) Can you think of another?

S14: Phosphoric acid?

T: That's another good one. (PAUSE while writing on board). (26) Which acid do you think we should use. . .uh, let's see, who haven't I called on yet? Ronnie? Which one of these acids should we wash the new stopper with?

S15: HCl.

T: O.K. (27) Is that all right with everybody?

S14: Naw, I wanna use phosphoric acid.

T: O.K. let's use both of them and then we can be double sure. (28) Phillip, would you and Kent go and get some acetone, benzene, gasoline, HCl, phosphoric acid, and. . .uh. . .some ether? . . . and a new stopper? It's a number three if you get a rubber stopper.

(LONG PAUSE during which the chemicals are fetched, several students participate in washing the new stopper, etc. etc.)
T: O.K., Allen and Barbara approve the stopper washing so we're ready to test Diane's hypothesis.
(PAUSE followed by chorus of "Oh, No," "It turned blue,"etc.)
T: Well, it still turned blue. (29) Now what. . .Laura?
S16: Could we observe it some more?
T: (30) Are you going to observe it differently from the way you did the first time?
S16: Uh. . .Well. . .everybody was passing it around and all that and it never did turn completely colorless like everybody is saying that it did. . .But it's colorless NOW. Could we just kind of look at it while it's sitting up there on your desk?
T: O.K., Observe away. (31) Does anyone want to get up and observe it? I'll give you. . .two minutes. (LONG PAUSE) All right everybody have a seat. (32) Did anybody see something different this time?
(SEVERAL STUDENTS ANSWER SIMULTANEOUSLY AND NONE ARE UNDERSTANDABLE)
T: Kenneth?
S17: I know something else that's in the flask.
S6: WHAT?!!!
S17: Air. That's what makin' it turn blue. The stuff is reacting with air.
T: (33) What observation led you to that hypothesis, Kenneth?
S17: Ask Laura. She's the one who showed it to me.
S16: Showed you what?
T: (34) Did you show him any of your observations, Laura?
S16: Oh, yeah. . .When you kneel and look up through the solution from the bottom, it looks like the top is real blue, kind of like looking up into the sky except a different color blue, just like the color when you shake it up.
T: (35) How do you think that convinced Kenneth that air is what's turning the solution blue. . .Chris?
S18: It's HIS hypothesis. Ask HIM!
T: Well, I'm asking you right now.
S18: Well I don't know.
T: I know you don't know what he thought. (36) How do you think that Laura's observation relates to Kenneth's hypothesis?
S18: (LONG PAUSE) Well. . .(PAUSE). . .There sure is air in there, that's for sure. . . .I don't know (LONG PAUSE) Well, I just don't have ANY idea.
T: (37) Kenneth, would you explain to all of us how you reached that hypothesis?
S17: Chris, what's the only thing in contact with the surface of the water all the way across?
S18: (PAUSE) Air, I guess.

S17: What color is the surface of the water all the way across if you look up at it from the bottom?
S18: Blue?
S17: Right. So what has to be turning it blue? What's the only thing that's touching it where it's blue?
S18: OH! OF COURSE! Its AIR!!. . .Sure!!!
S6: Why doesn't it look blue when you look down on it from the top?
T: That's a good question, Allen. (38) Why doesn't it look blue from the top Kenneth?
S17: I don't know. It should. I didn't look at it from the top.
T: Well, (39) Why don't you get up and do it now? (LONG PAUSE).
S17: Allen, you dummy. It does look blue from the top.
S6: Huh? Leume see. (LONG PAUSE) You're right. It is blue from the top.
T: O.K. (40) So how could you test his hypothesis Derwood?
S14 (PAUSE) Take the air out?
T: O.K. You could take the air out. (41) How could we do that, Sharon?
S19: Hook it up to the aspirator. (PAUSE) Well, we'd have to get another stopper. . .one with a hole in it and some glass tubing.
T: (42) How could we keep the air from going back into the flask once we had pumped it out?
S19: Well we could. . .(PAUSE)
S17: Use a tube with a stopcock in it.
S19: Yeah.
T: That's an excellent suggestion Kenneth but I wish you wouldn't break in on someone like that. (43) Do you think you could try to refrain from doing that in the future? If you'll hold up your hand you'll eventually get a chance if the person already talking doesn't think of your idea first.
S17: I guess so.
T: O.K. Good. . . .Well, let's do it. I just happen to have here a number three one-hole rubber stopper with a stopcock and vacuum tubing attached.
(Chorus of boos, hisses, "you had it planned all along," etc., etc.)
(LONG PAUSE with sound of running water)
T: (44) Is this long enough or do ya'll want to pump on it a little while longer?
(Chorus of "LONGER" followed by another PAUSE with running water)
T: O.K., I've closed off the stopcock. NOW let's try it. (PAUSE) (45) What happened, Kenneth?
S17: It turned blue still. . .but it wasnt as blue as before and it turned back quicker. Do it again.
T: O.K. (46) Now what?
S17: Well, it didn't turn blue so that proves it.
T: (47) Proves what?
S17: That the air was what was making it turn blue!

T: (48) Is that all right with everybody? Are you willing to accept this as evidence that the air was what was causing the blue reaction?
(CHORUS of "yeah," "sure," "It was the air," and so on)
T: (49) Is the air a chemical compound, Lamar?
S10: Mus' be.
T: (50) Wanda?
S9: No, it's a mixture of gaseous compounds and elements like nitrogen and oxygen and carbon dioxide.
T: That's right. (51) Lamar, can you think of another constituent that might be in the air?
S10: Uh. . .helium?
T: O.K. (writing on board) (52) Any more, Mary?
S3: Hydrogen, Argon, Xenon, Neon.
T: That makes eight real good ones. (53) Can anyone think of more, Sharon, did you have your hand up?
S19: If it's polluted air you might have carbon monoxide and ozone and nitrogen dioxide and sulfur dioxide and all kinds of stuff like that guy told us about in assembly last week.
T: (54) Do you think the air in the flask was polluted?
S19: Nossir.
T: O.K., well then let's leave those off the list -- but they would certainly be possibilities if our air were polluted like it is in Jackson. . . . O_2, N_2, CO_2, argon, He, Neon, H_2, and Xenon. That really about covers it. (55) Which one of those compounds do you think is most likely a culprit. . .let's see now. . . I haven't called on Lisa yet. . .which of these constituents do you think is most likely to be causing the reaction, Lisa?
S20: Oxygen.
T: O.K., oxygen. (56) Jan, do you agree with that?
S21: Yeah, that's O.K.
T: (57) Why do you think it might be oxygen, Jan?
S21: I don't know. I just agree with Lisa.
T: Hmmmmmm. That's not a very safe way to get your ideas. (58) Do you always depend on other people to tell you what to think?
S21: I sure do in chemistry.
T: O.K., I guess that's fair if you're willing to trust what she has to say. (59) Sandra, why do you think Lisa said it was oxygen?
S22: Sir:
T: (60) Why do you think Lisa said oxygen was the gas in the air that caused the stuff in the solution to turn blue?
S22: I don't know.
T: (61) Well, if you had said oxygen, why would you have said it?
S22: I wouldn't say oxygen. I'd say CO_2.

T: Oh, I see. O.K., then, (62) why would you say carbon dioxide?
S22: Because. . .uh. . .Do you remember when we. . .uh (LONG PAUSE) No that was in biology last year. (PAUSE) Well, anyway. . . CO_2 makes things turn white when you blow your breath into solutions through a straw so maybe that's what makes this solution change colors.
T: WOW! Coach Gaston is really going to be pleased when I tell him you're applying what you learned last year in his class to chemistry this year. . . .Let's see if I can get this straight now. You're saying that the CO_2 in your breach makes some solutions like barium hydroxide turn white and since it causes a color change in that reaction, it might be causing a color change in this reaction, too. (63) Is that about right?
S22: Uh-huh. I guess so.
T: That's a pretty good hypothesis. Ronnie. . .
S15: I know. (64) How could I test her hypothesis?
T: Well, that's not the question I was going to ask and I'd appreciate your not interrupting me until I finish talking. I'll give you the same courtesy as long as we're talking about chemistry. (65) Now, would you like to agree with one of these hypotheses or do you have a third possibility?
S15: Oh (PAUSE) Leeme see, . . .uh. . .that might be nitrogen.
T: (Writing on board) Nitrogen. (66) Why not one of the others, Phillip?
S1. They're all inert except hydrogan and there's not enough of that in the air to worry with.
T: O.K. (67) Does anybody disagree with that? Lamar?
S10: Why don't you just tell us how it works and then we'll know?
T: Lamar, I must have answered that question for you two-hundred times this year. I'm not goin to go into it again. (PAUSE) (68) How could you tell which one of these might be right, Kenneth?
S17: Well, we've got little tanks of O_2 and N_2 in the storeroom. Have we got any dry ice left over from the experiment we did Friday?
T; Uh-huh. I think so.
S17: Throw a piece of dry ice in the solution. If it turns blue around the dry ice, CO_2 is doing it. If it turns blue when you bubble O_2 or N_2 through it, then <u>that</u> gas is doing it. . .
T: (60) Is that O.K. with everyone? (LONG PAUSE) O.K., I'm going to use this deflagrating spoon to put a piece of dry ice down in the flask. That way we can get the dry ice back out. Everybody watch. (PAUSE) Derwood, turn around and pay attention. You should be watching this too. (LONG PAUSE) Hmmmm. The dry ice doesn't seem to be having any effect. Let's try nitrogen. (LONG PAUSE) (70) O.K., what's happening Sandra?

S19: It's turning blue a little bit, especially near the top.
T: O.K., then let's try oxygen and see what happens with that.
(LONG PAUSE followed by "Oh wow", "Far out," "look at that," etc.)
T: Well, I guess Lisa was right. That sure was excellent reasoning that Sandra had though. I'm really impressed. It just didn't happen to work this time. (71) Lisa, why did you think it would be oxygen instead of one of these other gases?
S20: Well, Oxygen reacts with a lot of different things and it makes up about. . .let's see, what was it? (PAUSE) . . .about 30% . . .about 30% of all the stuff that makes up air. CO_2 is real reactive too but there's not very much of it in the air. That's why you have to breathe through a straw in biology instead of just pumping air in it with a bicycle pump or something. So I didn't think there would be enough of it in the air to keep making the color change and change and change without ever taking the top off. (PAUSE) It would get used up faster than that since there's not very much of it in the air to begin with. . . .You know? . . .(PAUSE) Well, I could tell that something in the air was being used up because when you took the original stopper out. . .you know, to put in the specially cleaned one? . . .anyway, it sounded like that. . .like there was a vacuum in there. (PAUSE) So I figured something in the air was being used up. And we've already learned that nitrogen isn't very reactive as N_2, so oxygen was about the only thing it could be . . .you know?
T: That's really far OUT!!! I am continually amazed at the way you folks can think when you get cranked. Phillip and Allen and Kent are usually the idea men--excuse me, the idea persons--and today already, Kenneth and Wanda and Sharon and Diane and Giselle and especially Lisa have had some really supper ideas and thinking. Some other folks like Derwood and Barbara have come up with some excellent experimental designs which is at least as important to doing science as thinking up theories is. I am really impressed. (72) It couldn't be due to the fact that I'm taping the lesson, could it? (PAUSE) Yes? Well, I think I'll just tape every lesson from now till the end of the semester. I don't know. If I did that ya'll might end up being chemical geniuses and I'm not sure we could stand 24 geniuses in chemistry in the same classroom. . .or even in the same town for that matter.

After you have coded all 72 questions in this transcript on a separate sheet of paper, turn to page 8 of the KEY BOOKLET to check your coding.

Written Program Exit Assessment: transcript two

If you are coding this transcript for fun, please begin below. If you are coding it because you did not code the first Exit Assessment transcript at the 80% level, please read the following comments.

An 80% level of accuracy in coding questions in written transcripts is required as an exit competency for this component of the module. Before coding this second transcript, you should be certain that you understood the categories you missed in coding the previous transcript. This may require that you work through certain portions of the written program again. If you wish to do so, or feel that this is necessary, the eleven basic categories and the appropriate sections in the written program are listed below.

1 -- p 3
2A -- p 14
2B -- p 19
3A -- p 30
3B -- p 43
3C -- p 66
4A -- p 76
4B -- p 84
4C -- p 93
5A -- p 113
5B -- p 118

After you have reviewed the question category classification system to your satisfaction, please code the following transcript which was taken from an advanced biology class. Students are in the 10th, 11th, and 12th grades with the majority of them being seniors. They have all had a year of biology and most of them have had chemistry as well.

T: That's an interesting question Robert. Let's see if anyone can answer it.
(a) Leslie what do you think?
S1: Uh. . .I did't hear what he said.
T: (b) Robert?
S2: I said what's the difference between instinctive behavior and conscious behavior?
S1: Oh, well. . .An instinct is something that you do naturally.
T: (c) Is thinking natural?

S1: (LONG PAUSE) Yeah, I guess it is. What I meant was that an instinct is something you can do without having to think about it. . .Like when something comes at your eyes, you blink. That's an instinct.

S3: Naw, man, that's a reflex action.

T: (d) What's the difference between a reflex action and an instinct, James?

S3: A reflex action is something that happens automatically. (LONG PAUSE). Like if somebody pokes at your eye, your brain doesn't have to think about it to make your eyes close. The nerves that cause your eyes to close are attached more or less directly to the nerve that sense when somehin' is fixin' to hit you in the eye and it closes automatically. (LONG PAUSE)

T: All right, that's a pretty good explanation of a reflex action and how it works, but (3) how is that different from an instinct?

S3: (LONG PAUSE) An instinct has to go through your brain? (LONG PAUSE)

S4: People don't have instincts!

S3; How do <u>you</u> know?

S4: People have reflex actions but they do everything else consciously (LONG PAUSE)

T: You're saying that humans don't act instinctively at all. (f) Is that right, Pam?

S4: Uh-huh.

T: Well, (g) what is an instinct? Tell us what you mean when you say "instinct."

S4: An instinct is a long series of actions that an animal does in a certain situation and every member of that species does exactly the same series of actions in the same situation. (LONG PAUSE) I can't think of an example right now.

S5: When a dog rolls over at the end of a fight when he'd been whipped, that's an instinct.

T: All right, Billy Ray, that's a pretty good example. (h) Why do you think that is an instinctive action?

S5: Well, I got a bunch of dogs--in fact, my daddy raises dogs for a livin'--and every time there's a fight between two dogs, the one that gets whipped rolls over on his back when he's ready to give up. Even the young dogs do it, the ones who have never been in a fight before. . .And they all do it the same way too. They all look the same. And it's the same way for pointers as it is for German Shepherds and Labs.

T: That certainly fits Pam's definition of an instinct all right (i) Sherman, did you raise your hand?

S6: Yes'm (PAUSE) I just wanted to say that I don't think that's an instinct. Those dogs know they been whipped and they just lettin' the other dog know it so that won't get hurt no more. That ain't no instinct; that's just good sense.
S5: How come they all roll over the same way every time, turkey?
S6: They seen other dogs do it that way 'fore they ever got in a fight themselves, chump!
T: Sherman, Billy Ray, don't call people names in my room. You both know better than that. (PAUSE) (j) How could you tell whether that rolling over behavior was instinctive like Billy Ray says or learned like Sherman says, Leo?
S7: That's easy. Just raise some puppies by themselves so they ain't never seen no other dog fight. Then let 'em get in a fight with another dog. If all the dogs raised by themselves turn over the same way that Billy Ray's dogs do, then it's an instinct. If they don't, then Sherman's right and they have to learn how to do it by watching other dogs.
T: (k) Do you think that's a fair way to test it, Billy Ray?
S5: Uh-huh, that's O.K.
T: (l) Sherman?
S6: Yeah, that's fair.
T: (m) How long would it take to do that, Billy Ray?
S5: Bout a year before they'd get big enough to fight. (PAUSE) But I'm gonna try it. I'll tell you next year.
T: That would make a real good science project. Be sure to keep careful notes on everything you do so you can write your experiment up. (PAUSE) All right, let's get back to this definition of instinct that Pam gave a minute ago. (n) Can anybody think of an example of instinctive behavior? Mary?
S8: I'm not sure about this but wouldn't birds building nests be an example? (PAUSE) I mean, all sparrows build nests just alike. And all bluejays build nests just alike. But sparrows nests aren't like bluejay nests. (PAUSE) Like, uh, well, each kind of bird builds its special kind of nest by instinct.
S6: All sparrow nests ain't exactly alike either.
S5: Yeah but they're a lot more like other sparrow nests than they are like bluejay nests. You just too dumb to catch on.
T: BILLY RAY!! (l) Would you like to spend the rest of the period in the storeroom?
S5: No Ma'am.
T: Then I don't want to hear you talking like that again.
S6: Yeah, chump!
T: That goes for you too Sherman (PAUSE) Sherman <u>did</u> bring up an interesting point. Pam, you said that every animal in a certain species would perform exactly the same series of actions under certain conditions and Billy Ray mentioned that

all his fighting dogs rolled over in exactly the same way. (p) Do you wish to maintain your definition as is or would you like to change it a little?

S4: Well, maybe I should have said a whole lot alike instead of exactly alike.

T: O.K. (q) Sherman, would you be willing to say bird nest building is instinctive if we redefined instinctive as acting a lot alike instead of exactly alike?

S6: Yeah, I guess so.

S5: And I never did say those dogs turned over exactly alike. Just that they did it the same way.

T: All right. We seem to have a definition everybody can agree on and a couple of really fine examples for instincts so. . .(r) Sherman? Did you want to say something?

S6: How do you know birds don't learn how to build nests? I mean, they're raised in nests just like they one they end up building, ain't they? How do you know their mama don't teach 'em about nest building?

T: Another good question, Sherman. Socrates would have loved you. (s) Mary would you answer that question? How could you determine whether or not nest building behavior in birds is instinctive or learned?

S8: Could you take the eggs out of the nests before they hatched and hatch them in one of those things they use to hatch chickens? Then when they grow up, let 'em go and see what kind of nest they build? (PAUSE) If they learned about nest building from the mother, they wouldn't even know how to build a nest would they?

T: O.K. (5) How does that sound to you Deedee? Would you do the experiment like that or would you want to change something?

S9: I don't like it. It would be too hard to follow the birds around after you let 'em go. How would you follow them around? (pause) I mean, it's a really good experiment except that it would be too hard to follow the birds around once you let 'em loose. If there was a way to do that, it would be a good experiment.

T: All right. We've got to figure out some way to follow the birds around so we can see what they do. (u) What are some other problems with Mary's experimental design, Randy?

S10: How are you going to keep the baby birds alive? I've tried to raise baby birds before and all but one of them died. And I've been real careful too. I've kept them warm and given them mashed bugs and worms with a medicine dropper and fed 'em orange juice with vitamins and stuff in it.

T: (v) What did you differently for the one that lived?
S10: Nothing that I know of, he was just tougher than the others.
T: (w) Then what would you recommend for the experiment since you are our resident expert on baby bird raising.
S10: You'd better start with a lot of baby birds if you want very many to live to build nests because most of them are gonna die while they're babies.
T: All right, according to Randy, we should hatch a large number of eggs in order to get a large enough number of birds to live to the nest building stage. (x) Can you think of another problem with the experimental design, Susan?
S11: If they learn nest building from their mama, it seems like they could also learn nest building from other birds too. If you let them go wild they could contact other birds who had learned to build nests and get what to do from them. Or they could just observe the nests of other birds in the wild and figure out how to build their own nests. (PAUSE) I mean you can't be sure that they didn't learn their nest building behavior if you just let them loose.
S7: That's easy to take care of. . .just build 'em a great big cage with some small trees and stuff inside it. That ought to solve Deedee's problem too because if they were in cages you wouldn't have any trouble keeping up with them.
T: (y) How big would a cage like that have to be?
MASS CONFUSION WITH NO ONE ANSWER UNDERSTANDABLE. THEY ALL ANSWER SIMULTANEOUSLY
T: Randy, you seem to be the resident ornithologist (z) How big should it be for, say, English sparrows?

After coding this transcript, please turn to page ten of the KEY BOOKLET to check your answers.

KEY BOOKLET

(a) No Code -- This question is followed immediately by another question. The student chooses to answer the second question and the first question is not a 1, so it should not be coded.
(b) 2A -- Recall of definition
(c) No Code -- Do not code questions that are asked by students, only those asked by teachers.
(d) 2A -- This is a repeat of question (b) and is coded similarly.
(e) 2A -- Answers to 2A questions are not really open for evaluation since the "yes" or "no" is clearly right or wrong. Therefore, asking a student to agree or disagree with the answer to a 2A question is really asking that student to answer the same question.
(f) No code -- See explanation for question (a) above.
(g) Other -- The teacher is requesting hypothesis formation, therefore this question would be coded as a 4C. A clue that they have not studied the answer to this question is the long silent period. Usually if an answer has been previously studied, at least one student will have either learned the answer or will know where to look the answer up in the text or notes.
(h) Other -- Hypothesis formation questions are coded as 4C.
(i) Other -- " " " " " 4C.
(j) No Code -- Only teacher questions should be coded when using this question category classification system.
(k) 1 -- This a command expressed in interrogative form.
(l) Other -- The teacher's strategy is a bit unclear here but you have to assume that he was seeking an answer rather than attempting to put the student on the spot. Had Eric answered the question, his answer would have certainly been accepted. Code this 4C.
(m) Other -- Since the teacher waited for an answer to the question, this should probably <u>not</u> be coded as a 1. The student is being asked to actually evaluate his behavior so this is coded 5A.
(n) Other -- Same as above, 5A.
(o) Other -- Questions which elicit hypothesis formation are coded 4C.

If you miscoded more than 3 questions, please check the explanations given above with the questions as they occur in the transcript. Then continue working through the program by turning to page 20.

If you missed three or fewer question codes, turn to page 29 in the written program.

(a) Other -- Assume that the teacher will accept whatever it is that Irving knows; code this 4A -- a completely open question.
(b) Other -- The category system doesn't cover this type of question so it should be coded with a "o".
(c) 2A
(d) 2A
(e) 2A
(f) 2A
(g) Other -- since the teacher asked for "a measure" rather than "THE measure," this is an open question and is coded 4A.
(h) No Code -- Only teacher questions are coded in this system.
(i) 2A
(j) 2A -- Although this is an agree/disagree questions, it refers to the answer for a memory-recall question and is coded 2A.
(k) Other -- a completely open question with many acceptable answers: 4A.
(l) Other -- an open question: 4A
(m) 2A -- This could also be a 3A question in context since the student could be using a given or learned sequence of reasoning to produce the correct answer. However, in the context of this lesson and especially with the context of this student's previously facile answers, the question is probably memory-recall.
(n) 3A -- Student is being asked to produce a right answer using a learned sequence of reasoning.
(o) 1
(p) 1
(q) 3A -- producing right answer with learned or given reasoning sequence.
(r) 2A
(s) 3A
(t) 1 -- teacher answered her own question, so this is rhetorical
(u) 3A

If you have recoded this transcript as per directions on page 83, turn to p. 82 in you missed any of the 4A questions. If you properly coded the 4A questions, turn to pl 84 in the written program.

If you have coded this transcript for the first time as per directions on p. 42 of the written program, count your misses. If you miscoded more than 4 questions, review the category definitions for the type of question you missed (1, 2A, 2B, 3A, and eother) and then compare the explanations given above with the transcript which begins on p. 40 of the written program.

If you miscoded 4 or fewer questions, turn immediately to p. 43 of the written program.

(a) 3B -- Asking for an inference from data
(b) 3B -- " " " "
(c) No Code -- categorize only teacher questions
(d) Other -- Questions requesting experimental design are coded as 4B.
(e) Other -- Since either of the variables would be acceptable, this is an open question: 4A.
(f) 1 -- A context clue that this is a procedural question is the teacher's asking the entire class rather than a specific person.
(g) 3A -- the student's answer is sufficient context to indicate that they have learned a set procedure for answering this question.
(h) 3A -- same as above.
(i) 3A -- In context, this is a 3A but you don't hear the student answer providing the context clue until much later. If you coded this as "other" (4A - completely open question), don't count this as a miss.
(j) 3A -- There is only one right answer to the answer being evaluated, so the agree and disagree options are not equally acceptable. This is just asking the same question again in different form.
(k) 3B -- Student asked to provide reasons for giving a previous answer.
(l) 3B -- Asking for an inference from data.
(m) 3B -- " " " "
(n) Other -- Questions eliciting hypothesis formation are coded 4C.
(l) Other -- Questions eliciting experimental design are coded 4B.

If you missed 4 or more questions, please review the categories with which you had trouble by rereading the short discussion in the introduction booklet. If necessary, review the appropriate section of the written program (1--p. 3; 2A - p. 14; 2B - p. 19; 3A - p. 30; 3B - p.43). After reviewing the categories you missed, close the key booklet and recode the transcript beginning on p. 62 of the written program.

If you missed 3 or fewer questions, please turn to page sixty-five in the written program.

(a) 1 -- managerial; teacher is asking for a volunteer
(b) 2A -- memory-recall (that they have studied this is obvious from their answers)
(c) Other -- Open question with many acceptable answer; 4A
(d) 2A -- a recognition question
(e) 2A
(f) 1
(g) 2A -- another recognition question: see it and name it
(h) 2A
(i) 2B -- simple observation
(j) 3B -- student asked to cite reasoning behind previous answer.
(k) 2A
(l) 3B -- prediction from sufficient experiential base (assume that ninth graders have seen balloons blown up, even if not in science class)
(m) 1 -- The teacher is expecting agreement. This becomes quite clear when one of the students disagrees.
(n) 3B -- Student asked to cite reasons for a previous assertion
(o) 3B -- Asking for a prediction with sufficient data.
(p) 2B -- Although this may sound as if the teacher is requesting a hypothesis, the student's answer and the next question and answerprovide sufficient context for coding this as 2B.
(q) 2B -- Simple observation, just like the previous question, though it sounds somewhat as if the teacher is requesting hypothesis formation.
(r) 1 -- The teacher expects agreement. This could have been coded as a 3B question had the teacher worded the question a bit differently. It was not coded as a 3B in this case because the teacher told the student what he was predicting.
(s) Other -- While one is safe in assuming that ninth graders have observed balloons being blown up, one is probably not safe in assuming that they have seen this done at varying temperatures or that they have seen the temperature of a balloon varied. Since it is fairly obvious from context that they have not discussed the phenomenon in class and it is also obvious that the teacher is accepting several differing predictions, this question would be coded as a 4B --a divergent-production question which requests a logical prediction from an insufficient data base.
(t) 4B --same as above.
(u) 4B -- Even though only the student 's name is used, it is obvious that the same question is being asked when one hears the answer. Had the student not responded to the question but in some unrelated manner, one could be justified in coding this as a 1.

(v) 2B -- Request for an observation

(w) 3C -- One of the trademarks of 3C questions is that they are very difficult to phrase properly and a teacher often must try several times at phrasing the question before he or she is certain that the student understands exactly what it is that is being asked. What she wants him to do is mentally check out the comparison phenomenon he cited (i.e., the bicycle pump's heating up) and to figure out (1) why it did not apply as he thought it would; and (2) how he could explain what are, to him, discrepant events. Again, in context, it is obvious that the teacher is now seeking a "right" answer which is why this question is coded as 3C instead of 4C.

If you missed 5 or more question codings, please keep the key booklet open and turn to page 72 of the written program. Compare your coding and the explanation in the key to the transcript. If you are still unsure of the coding of a specific question, reread the discussion of the two categories in the introduction booklet and rework the appropriate sections in the written program (1 - p. 3; 2A - p. 14; 2B - p. 19; 3A - p. 30; 3B - p. 43; 3C - p.66). After doing this to your satisfaction, close the key booklet and recode the transcript beginning on page 72 in the written program.

If you have missed four or fewer, congratulations on your burgeoning expertise. Please turn to page seventy-six of the written program.

(1) 3B -- asking student to cite reasons
(2) 1
(3) 1 (If you have 4B here, or "other", you may have coded an un-numbered question)
(4) Other -- This requests a prediction from inadequate data; 4B
(5) 4B -- same as above.
(6) 2A
(7) 1
(8) 1
(9) 4B -- same as above (4 and 5). This could have also been a 1 had Ronnie's answer indicated that the question were managerial in context.

You should have missed 2 or fewer. If you correctly coded the un-numbered question as a 4B, give yourself a brownie point. If you coded question (9) as a 1 rather than a 4B, do not count a miss since it is really context dependent and you did not have the context (If you coded it as anything except a 1 or 4B, count it as a miss). If, after considering these exceptions, you still missed 3 or more, review the question categories you missed by reading the introduction booklet and reviewing the written program (1 - p. 3; 2A - p.14; 2B - p 19; 3A - p. 30; 3B - p. 43; 3C - p. 66; 4A - p76; 4B - p. 84; 4C - p. 93). After you are satisfied that you understand your missed codes, please turn to page 113 in the written program.

If you missed two or fewer questions, please turn to page 113 in the written program.

(a) 5A
(b) 5A
(c) 5A
(d) 3B -- asking for reasoning to support the previous answer
(e) 3B -- same as above
(f) 5A
(g) 1 -- This is definitely a procedural question. Had Carl answered "No," the teacher would probably have handled this quite differently.
(h) 5A

If you missed 2 or more questions, please review the categories you missed. This means reviewing the false positives as well as the negatives (e.g., if you coded a 5A question as 4C, you should review both 5A and 4C questions). If necessary, work through the appropriate sections of the written program. The pages for each category are listed below:

1 - p. 3
2A - p. 14
2B - p. 19
3A - p. 30
3B - p. 43
3C - p. 66
4A - p. 76
4B - p. 84
4C - p. 93
5A - p. 113
5B - p. 118

If you missed only one question, re-read the question in context and compare it to the coding given above. After you have justified the above coding to yourself satisfactorily, turn to page 118 of the written program.

If you didn't miss any codes at all, please turn directly to p. 118 of the written program. The end is in sight.

(1) 2B -- simple observation
(2) 2B
(3) 2B
(4) No code -- code only teacher questions
(5) 1
(6) 1
(7) No code -- teacher questions only with this question classification system.
(8) 2B -- Asking student to "translate" what was said into other words
(9) 4B -- experimental design question
(10) 1
(11) 4B -- experimental design question
(12) 3B --asking for reasons to support assertion
(13) 3C -- asking student to analyze a hypothesis and to find an observation that supports it.
(14) 3C -- repeat of above question
(15) 1 -- teacher asked student to confirm knowledge of a definition, not to cite the definition itself. Had the teacher requested the student to give the definition, this would be 2A
(16) 3C -- same as questions (13 and 14)
(17) 5A
(18) 4B -- experimental design
(19) 4B
(20) 3B -- asking for reasoning to support an answer
(21) 4A -- open question with many possible answers
(22) 4A
(23) 2A -- student is expected to remember a fellow student's response
(24) 4A
(25) 4A
(26) 4B -- experimental design
(27) 1
(28) 1
(29) 0 -- this might legitimately be coded as 4B except the student's answer never makes clear exactly what was being asked. Had the student responded with a suggestion for the next step in the procedure, this would have been a 4B. Poor phrasing makes interpretation of the question impossible, given no clear context clue such as a student answer.
(30) 0 -- This question does not fit very comfortably into any of the categories. It might be coded 1 with clearer context definition.
(31) 1

(32) 2B
(33) 3B
(34) o -- Again this doesn't fit easily into any category and one might be tempted to code it as a 1.
(35) 3C -- same reasoning as for (13 and 14)
(36) 3C
(37) 3B -- asking for reasons
(38) 4C -- asking for hypothesis formation
(39) 1
(40) 4B -- experimental design
(41) 4B
(42) 4B
(43) 1
(44) 1
(45) 2B
(46) 2B
(47) 2B -- student asked to translate "it" into language understood by other
(48) 1
(49) 2A
(50) 2A
(51) 4A
(52) 4A
(53) 4A
(54) 5A
(55) 4C -- hypothesis formation
(56) 5A
(57) 3B
(58) o
(59) 3C -- same as 13, 14, 351 36
(60) 3C
(61) 3C
(62) 3B
(63) 1
(64) no code -- student questions are not coded
(65) 4C -- The student answers the latter of two questions so only the latter question is coded.
(66) 4C -- hypothesis formation
(67) 1 -- In the context of Lamar's following question, it's clear that the second question "Lamar?" is procedural. Lamar had his hand up and is asking for permission to speak which is given.
(68) 4B -- experimental design
(69) 1
(70) 2B
(71) 3B
(72) 1 -- This is rhetorical. The teacher answers it himself.

If you miscoded 15 or more questions, please reread the transcript checking it against the key to clear up any misunderstandings. If necessary, review any categories of which you are still unsure. Then close the key booklet and re-code the transcript you just finished. When you have coded this transcript with fewer than 15 misses not using the key, turn to the second transcript in the "written program exit assessment" and follow the directions.

If you missed fewer than 15 questicns, proceed immediately to the audiotaped component of the module. Be sure to read the directions for coding audiotapes before beginning the audiotape component.

(a) o -- this question cannot be coded without prior context cues
(b) o
(c) 5A
(d) 2A -- second year biology students would be expected to have learned definitions for instinct and reflex action
(e) 2A
(f) 1
(g) 2A
(h) 3B
(i) 1
(j) 4B -- experimental design
(k) 5A
(l) 5A
(m) 3B -- Billy Ray is being asked to infer from his previous experience with dogs.
(n) 4A -- an open question with many correct answers.
(o) 1
(p) 1 -- considering the point just made, the answer to this is implied.
(q) 1 -- managerial; if Sherman says "no" a different kind of question will follow. Again the desired answer is implied by the teacher.
(r) 1
(s) 4B -- experimental design
(t) This is really two questions and the student answers them both, which makes it really difficult for coding. The first question is coded as 5A and the seccnd is coded as 4B.
(u) 4C -- analysis question with several possible answers.
(v) 2A -- memory-recall
(w) 4B -- experimental design
(x) 4C -- analysis question with several possible answers
(y) 4B -- experimental design
(z) 4B

If you missed more than five of the questions above, you may not have followed directions in the written program as carefully as you could have. If you have been turning pages before writing down you categorization of example questions and transcripts and/or if you have advanced to new sections before reaching the recommended criterion levels for previous sections, you should repeat the written program and follow the directions very carefully.

If you have faithfully followed the directions and have still not achieved the 80% accuracy level for coding written transcripts, there is a communication problem. Try to determine which category or categories we disagree on and determine what key words seem to be problems. It's quite possible that you disagree with the nature of the category system and are subconsciously using what you think it should be rather than what it is. If this is the case, try to use the category definitions even if you don't agree with them. If you wish to spend time writing suggestions, comments, recommended revisions and so forth, we would greatly appreciate your giving these to us so they could be used to restructure the module. It's also possible that certain key words have different connotations for you. If this is the case, try substituting synonyms which make sense to you in the context of the given examples and coded transcript. After doing this, recode the two transcripts in the written program exit assessment.

If you have missed five or fewer, you are ready to proceed to the audiotaped component of the module. Be sure to read the directions before beginning this component.

x	000-010	
2B	010-020	(observation question)
2B	020-030	(" ")
x	030-040	
3B	040-050	asking for reasons
4B	050-100	experimental design
3B	100-110	asking for reasons-what do you expect to find out?
x	110-120	Why did you choose that design?
x	120-130	
4B	130-140	prediction from an inadequate data base
5A	140-150	simple agree/disagree evaluation of previous prediction
x	150-200	

Did you miss more than two questions? If you did, don't feel bad--coding audiotapes is infinitely more difficult than coding transcripts. Rewind the tape and try again after closing the key booklet. Be sure to concentrate on the dialogue, excluding all extraneous factors from your attention.

If you missed two or fewer, you are now an expert coder. A 70% accuracy level is a very high level of skill for coding audiotaped episodes. Please start the tape and proceed with the audiotaped component of the module.

4A	000-010	open question with many possible answers
1	010-020	procedural -- "Who uses volume?"
1,o	020-030	First question is procedural. Second unintelligible
2A	030-040	memory-recall
4A	040-050	another completely open question
x	050-100	
x	100-110	
o	110-120	unintelligible
2B,2A	120-130	First is translation type ("What do you mean by. . .?)
x	130-140	and the second is memory-recall)
x	140-150	
x	150-200	

A comment not directly related to the subject of classifying questions in science classes: The students interrupt the teacher while he is talking -- but he does the same thing to them. Do you hear your students interrupting you? If so, listen to your tapes to see if you interrupt them too. Except for this, the lesson is a good example of teaching in which the teacher relates the subject matter to the every-day out-of-school life of his students.

If you managed to hear all the inaudible unintelligible questions, there are 10 possible questions with correct coding on at least seven of them the criterion level. If you did not hear some of the "o" questions, calculate the number of questions you coded x 0.7 gives the number of questions you should have coded correctly). If you coded the episode at below the 70% level of accuracy, please rewind the tape and attempt to resolve any coding discrepancies by listening to the episode with key in hand. Then code the next, and final, episode.

If you successfully coded this episode at or above the 70% level of accuracy start the tape and code the next, and final, episode.

2B,"	000-010
2B	010-020
x	020-030
2B	030-040
x	040-050
1,2B	050-100
x	100-110
x	110-120
1, 3B	120-130
2B,2B,"	130-140
4C	140-150
"	150-200
x	200-210
x	210-220
x	220-230
1	230-240
4C	240-250
1, 4C	250-300
1	300-310
x	310-320
x	320-330
4C	330-340
x	340-350
x	350-400
x	400-410
x	410-420
4C	420-430
5A	430-440
x	440-450
1	450-500
1	500-510
1	510-520

When the teache r recorded this lesson, she left both the air conditioner and the aquarium pump on, which explains the roar in he background. You can hear her fairly well despite this interference because the microphone is set up very close to her.

A very nice strategy which you may not have noticed (and which is not directly connected to the subject of this module!) is the teacher's interaction with Gina. Gina was asked to propose a hypothesis and had some trouble in doing so. A couple of minutes later, when another student gave a good answer, the teacher drew Gina back into the answering process with two procedural questions by asking her to share an evaluation of the answer with the teacher ("Gina, does that make sense to you?" and "It's a good idea, isn't it?")

SIX is the magic number this time. If you missed more than six you should probably review the introduction booklet sections on 2B and 4C questions before you rewind the tape, close the key booklet and recode this episode.

If you missed six or fewer, you are still coding at the 70% level or better--quite a feat. Please start the tape and code the next episode with equal facility.

1	000-010	The teacher implies an answer of "yes" to this question.
4A	010-020	An open question as evidenced by student answer
x	020-030	
x	030-040	
x	040-050	
2A,2A	050-100	Use of words like "potential" and "kinetic" indicate
2B	100-110	Translation prior study.
2A	110-120	
x	120-130	
x	130-140	
2A	140-150	
x	150-200	
x	200-210	
2B	210-220	Another translation question (What do you mean by
x	220-230	that?--i.e. please rephrase that in other words
x	230-240	so we can understand)
	240-250	

Quality recordings just can't be made in some classrooms because of the acoustical design and this is one such classroom. You can, however, understand what he says if you pay careful attention.

Only eight questions were asked during this short episode and you should have coded at least six of them correctly to maintain a 70% accuracy level. As mentioned above, context clues indicate that the kids have studied energy and heat prior to this lesson, making many of the questions memory-recall and translation type questions (2A and 2B). Please start the tape and code the next short episode.

4A	000-010
3C	010-020
"	020-030
5A	030-040
3A	040-050
1	050-100
3B	100-110
x	110-120
x	120-130
1	130-140
1	140-150
5A	150-200
5A,3B	200-210
5A	210-220
5A, o	220-230
5A	230-240
1	240-250
1	250-300
x	300-310
x	310-320
3B	320-330
1	330-340
5B	340-350
x	350-400
x	400-410
x	410-420
x	420-430
5A, 3B	430-440
x	440-450
x	450-500
x	500-510
x	510-520
x	520-530
5A	530-540
4B	540-550
4B	550-600

Another valuable lesson about coding audiotaped lessons is that it helps to have a high quality recording. Unfortunately, the quality of this recording is typical of the recordings many teachers make for a variety of reasons, not all of which are under the control of the teacher.

Like many teachers, the teacher you just heard paces his lesson a bit too fast and interrupts his students while they are talking. These are the minor flaws in what seems to be an otherwise excellent teach.

If you miscoded MORE THAN 7 questions, you did not code this episode at the 70% criterion level. If so and your missed coding was due to problems with hearing what was being said, rewind the tape and recode the epidose now that you are more familiar with the lesson. If you heard the questions but are unsure of some category assignments in the key, rewind the tape, study the introduction booklet for those categories you missed, and listen to the episode with key in hand to resolve the discrepancy.

If you missed 7 or fewer questions, read the note below and then start the tape to code the next episode.

NOTE: Inadvertently, the page of the key booklet corresponding to the next episode was omitted from the audiotaped commentary which accompanies each episode. The proper key booklet page for the next episode is 19. Do not turn to that page until AFTER you have coded the next episode.

x	000-010
4A	010-020
4A	020-030
2A	030-040
1,1	040-050
2A	050-100
2A,2A	100-110
1, 2A	110-120
2B	120-130
2A, 1	130-140
2A, 2A	140-150
2B	150-200
2A, 1	200-210
x	210-220
x	220-230
4A	230-240
2A, "	240-250
"	250-300
2A, 2A	300-310

(Even though it later becomes obvious in context that he want to elicit a specific answer, i.e., "evaporation" and "condensation," this first question in the series should be coded 4A since it is initially open. See coding rule 1f. in the introduction booklet)

This is a good review session. Many of the questions are memory-recall with a few translation type questions and a few open questions thrown in to improve communication and build interest. This teacher also uses rhetorical questions quite a bit. The pacing is rapid but probably not too rapid for the participating students since it is fairly obvious that they are keeping up with him. Many different students are afforded opportunities to answer questions.

If you missed more than SEVEN questions, you should review the coding rules in the introduction booklet. This episode moved rather rapidly but the questions were straightforward and the recording quality was good so any problems you may have had in coding should have stemmed from not remembering the rules at the end of the introduction booklet. After reviewing the decision rules and any categories about which you still have doubts, rewind the tape and recode this episode.

If you missed 7 or fewer questions, you are coding at or above the 70% accuracy level. This is quite good. Keep up the good work when you start the tape and code the next episode.

2A	000-010		x	500-510
2A	010-020		2A, 2A	510-520
"	020-030	(he only calls	x	520-530
2A, "	030-040	a kids name -	x	530-540
x	040-050	"Tommy?" but this	4A	540-550
x	050-100	is a repeat.)	x	550-600
4A	100-110		"	600-610
"	110-120		1	610-620
"	120-130		3B	620-630
5A	130-140		x	630-640
"	140-150		1	640-650
1, 3B	150-200		4A	650-700
5A	200-210		1	700-710
3B	210-220		3B	710-720
x	220-230		x	720-730
x	230-240		1	730-740
1	240-250		2A	740-750
1	250-300		2A	750-800
x	300-310		x	800-810
1	310-320		4A	810-820
x	320-330		x	820-830
3B	330-340		x	830-840
3B	340-350		1	840-850
x	350-400		x	850-900
4A	400-410		4A	900-910
1	410-420		x	910-920
2A	420-430		x	920-930
3B	430-440			930-940
x	440-450			940-950
1	450-500			950-1000

The kids are pretty noisy but the teacher seems to accept the noise with no problem. Sometimes the noise level during a lesson can get fairly high if teachers elicit answers to a series of open questions, especially if they aren't accustomed to open questions in their everyday school situation (and remember that their everyday school situation includes more than just your science class).

There are 41 questions asked by the teacher in the episode you just analyzed. If you correctly categorized at least 29 of these questions, you have coded the episode at the 70% or better level or accuracy. If you <u>have</u> coded the final episode at the 70% or better level of accuracy, you are now ready to analyze your own teacher to determine what kinds of questions you ask.

PLEASE TURN TO THE NEXT PAGE

Remember that the ideal model of teaching with questions that is stressed in this module is the use of many different types of questions. Because certain types of questions lend themselves to certain objectives and certain types of activities, you will not be fair to yourself if you examine only one example of your teaching. To obtain an accurate estimate of the types of questions you ask, you should listen to several short samples of your teaching on different days--perhaps 5 minutes early in a lesson and 5 minutes a bit later in the same lesson, repeating the procedure for two or three lessons until you have analyzed 20-30 minutes of your teaching. Since all eleven types of questions can relate to legitimate objectives of science teaching, you should find yourself using many of these eleven types of questions. If you find yourself consistently using only a few types of questions in different lessons, perhaps you should plan to use types of questions you do not normally ask, including them in future lessons for which questioning is an appropriate strategy.

4A, 2A	000-010
2A	010-020
4A	020-030
x	030-040
x	040-050
x	050-100
x	100-110
x	110-120
x	120-130
4A	130-140
2B,2B,4B	140-150
4B	150-200
4B	200-210
4B	210-220
1	220-230
1	230-240
x	240-250
1	250-300
x	300-310
x	310-320
4B	320-330

This series of questions regarding the depth of the picture of the coke bottle are classified 4B because the students are being allowed to generate their own definitions of what constitutes depth. Both yes and no answers are being accepted by the teacher but the students are not really evaluating anything which eliminates 5A as a possible category classification.

Because it is possible to miscode the "Does this bottle have depth?" questions and miss five questions immediately, that series of questions should be counted as one question for the purpose of scoring your coding accuracy. You should, however, have coded those questions with the same designation whether or not you coded them correctly as 4B questions; if you did not, you should try to be more consistent in your coding.

Counting the five "depth questions" as one question, there are 10 questions and you should have coded 7 of them correctly to maintain a 70% accuracy level. If you missed more than three questions, or if you were not consistent in coding the "depth" questions, please resolve the errors by referring to the introduction booklet if necessary. Then close the key booklet, rewind the tape and recode this episode.

If you missed three or fewer and especially if you coded the 4B series accurately, congratulations. Please start the tape and listen to the remainder of side A.

DIRECTIONS FOR CODING AUDIOTAPED, VIDEOTAPED AND/OR LIVE CLASSROOM EPISODES FOR THE TYPES OF QUESTIONS SCIENCE TEACHERS ASK.

In order to get some idea of pacing when coding classroom questions, use a stopwatch or a watch or clock with a sweep second hand and code questions in ten second intervals, using code sheets similar to the attached code sheets.

(1) If a question is asked during the ten-second interval, write the appropriate code on that interval line. For example,

2B 340-350

(2) If no question is asked during a particular ten second interval, make a check mark or an x on the interval line corresponding to that interval. For example,

350-400 730-740

(3) If more than one question is asked during a certain ten second interval, code all questions asked, separating each code with a comma. For example,

000-010

(4) If a teacher asks the same question several times in succession such as is common in using the eliciting strategy, use the full code designation for the first time the question is asked and use ditto marks for each succeeding time that question is asked until a different question intervenes For example,

4A	320-330
4A	330-340
"	340-350
" , "	350-400
x	400-410

The teacher began this sequence by asking an open question, then asked a different open question which was used three more times (Once it was used twice within a ten-second interval.)

The pacing can be a very important context clue for applying the decision rules found at the back of the introduction booklet. For example, teacher often ask 2A and 2B questions at a little faster question-answer pace than they ask the category 3, 4, and 5 questions. For the purposes of analyzing the tapes of your own teaching or the

teaching of a colleague, the pacing is important for spotting patterns such as not allowing sufficient time to think up answers to 3B, 3C, 4B, 4C, and 5B questions.

On the back of this sheet is an example of a time-coded post-lab lesson with margin comments to explain what was actually being asked. In coding lessons, you would not normally include extensive notes, although space has been provided on the code sheets for short notes.

2A	000-010	teacher is reviewing what was done during the experiment the day before
✓	010-020	
2B	020-030	Asking for experimental data. This question is used several times to elicit answers from different students
✓	030-040	
✓	040-050	
✓	050-100	
✓	100-110	
3B	110-120	Inference type of question. What would happen under similar circumstances?
✓	120-130	
2B	130-140	Request for clarification. Would you please rephrase your answer?
3B	140-150	Why do you think that would happen? What are your reasons for making this prediction?
3B	150-200	Rephrases the question so that the desired respondent understands what is being asked.
✓	200-210	
3B	210-220	Asks a different student for another inference from data
✓	220-230	
4B	230-240	Asks for another prediction not directly derivable from data
✓	240-250	
5A,5A	250-300	Do you agree with that prediction? type of question directed to three different students. On receiving a "NO" response from the third student, teacher asks a 3B question--Why don't you think that will happen?
5A,3B	300-310	
✓	310-320	
✓	320-330	
4B	330-340	Experimental design question--How could we tell the difference between these two predictions?
4B	340-350	Another experimental design question--tightening up details
✓	350-400	
4B	400-410	More design question related to distinguishing which of the two predictions is correct
5B	410-420	A student is asked to evaluate the design, given certain criteria.
✓	420-430	

Coding Sheet for coding audiotapes, videotapes, and live teaching

NOTES

_____	000-010	_____	800-810
_____	010-020	_____	810-820
_____	020-030	_____	820-830
_____	030-040	_____	830-840
_____	040-050	_____	840-850
_____	050-100	_____	850-900
_____	100-110	_____	900-910
_____	110-120	_____	910-920
_____	120-130	_____	920-930
_____	130-140	_____	930-940
_____	140-150	_____	940-950
_____	150-200	_____	950-1000
_____	200-210	_____	1000-1010
_____	210-220	_____	1010-1020
_____	220-230	_____	1020-1030
_____	230-240	_____	1030-1040
_____	240-250	_____	1040-1050
_____	250-300	_____	1050-1100
_____	300-310	_____	1100-1110
_____	310-320	_____	1110-1120
_____	320-330	_____	1120-1130
_____	330-340	_____	1130-1140
_____	340-350	_____	1140-1150
_____	350-400	_____	1150-1200
_____	400-410	_____	1200-1210
_____	410-420	_____	1210-1220
_____	420-430	_____	1220-1230
_____	430-440	_____	1230-1240
_____	440-450	_____	1240-1250
_____	450-500	_____	1250-1300
_____	500-510	_____	1300-1310
_____	510-520	_____	1310-1320
_____	520-530	_____	1320-1330
_____	530-540	_____	1330-1340
_____	540-550	_____	1340-1350
_____	550-600	_____	1350-1400
_____	600-610	_____	1400-1410
_____	610-620	_____	1410-1420
_____	620-630	_____	1420-1430
_____	630-640	_____	1430-1440
_____	640-650	_____	1440-1450
_____	650-700	_____	1450-1500
_____	700-710	_____	1500-1510
_____	710-720	_____	1510-1520
_____	720-730	_____	1520-1530
_____	730-740	_____	1530-1540
_____	740-750	_____	1540-1550
_____	750-800	_____	1550-1600

AUDIOTAPE COMPONENT

SIDE A

The tape begins with Donald Bird's "Ethiopian Knights," a composition which begins with a fairly simple drum part, adds several rhythm instruments one at a time until a quite complex rhythmic pattern is constructed from a number of much simpler parts. This occurs during a period of 3 minutes, 16 seconds at which time the music is faded to a low volume level and the commentator begins:

> By the time you hear this commentary, the music to which you have been listening has become quite complex. Many simpler parts have been interwoven to produce a composition that is certainly more than the sum of its individual parts. If you were asked to described what was happening in the music to produce the effect, you would have to perform a careful analysis of it, focusing on the individual elements and patterns until you could adequately describe those elements and patterns.
>
> But even if you focused on each part so that you could describe each in turn, you would have to answer NO to the question -- IS IT THIS PART THAT MAKES THE MUSIC WHAT IT IS? This is because, regardless of which part is considered, the overall effect of the music is due to each individual part and to the way in which the parts are blended.
>
> If someone asked you -- COULD I REPRODUCE THE COMPOSITION BY REPRODUCING THE BASIC PARTS? __ you would again have to answer NO because each part of this composition is a pattern around which each instrumentalist improvises in relation to the improvisation of the other musicians. A group of musicians who had analyzed this music and discovered its basic patterns could produce a composition that was recognizable as the composition you are hearing but it would not be exactly the same piece of music because the individual personalities, creative abilities and musicianship of the individual improvisers would be reflected in their use of the basic elements and patterns which comprise this composition.
>
> By now you are asking -- WHAT DOES A DISCUSSION OF MUSIC HAVE TO DO WITH TEACHING? Well, teaching and jazz are very

similar in many ways. Both are supreme art forms at their highest quality and both can be learned at some level by almost anhone who is willing to spend enough time working at it. This jazz composition and a lesson conducted by a good teacher are both complex wholes made up of several smaller patterns and elements. The musicians or the teacher improvise on the basic patterns and elements to produce a well-integrated complex whole which can be attended to by a person for enjoyment or for learning. Those attending need not be intellectually aware of the elements and patterns which comprise the whole. The elements and patterns of either a teaching composition or a musical composition can be intellectually understood, analyzed and described if one is willing to focus on one element or pattern at a time to the exclusion of others which are equally important. This kind of focusing is important for the description of both jazz and teaching.

A common teaching/learning technique for musicians becoming jazz artists is to focus on the elements and patterns of performances by their peers and by acknowledged masters and it is here that the analogy breaks down because this kind of activity is not common in teacher education. The audiotaped component of this module is designed to help you learn to analyze teaching for one important pattern -- using different kinds of questions. When you have finished this module you should be able to analyze your teaching and the teaching of your colleagues to determine how patterns of questioning fit into improvised teaching compositions.

The commentary required 2 minutes, 58 seconds and following it, the music is faded back up for 20 seconds. Then the first audiotaped protocols occur, sans background music.

TEACHER: Can you see how a graph might . . . might help you to . . . . to uh . . . to, to see which would be more accurate and, and see how many people came out closer . . . than, rather than (unintelligible)? [12 seconds]

1 second silence

TEACHER: Glen, do you know what a variable is?
STUDENT: Yessir, I do.
TEACHER: I was asking Glen. Thank you, though, Everett. Would you tell us please? [9 seconds]

1 second silence

TEACHER: (Unintelligible) OK, so then if that's all they found, they really don't know any more than you do, do they?
CHORUS: Right! No! etc. etc. [9 seconds]

At this point, the background music is faded in and the commentator continues:

All the questions you just heard would be placed in the same category of the system you learned when you worked through the written programmed instruction. (PAUSE) What category would these questions be assigned to? (PAUSE) Stop the tape and write your coding down.
[14 seconds]

Background music is faded up for 28 seconds, then faded back down as the commentator says:

These questions would be coded as category one. If you did not code them as belonging to the first category, please rewind the tape and listen to them again.
[9 seconds]

Background music is faded up for 20 seconds.

Throughout the audiotaped portion of the module you will be coding individual questions in classroom sequences of varying lengths, all of which have been derived from audiotapes made in real classrooms. Since you would normally use written materials to aid you in any analysis of classroom situations, you should feel free to use the written synopses of the category system included with the module. Also feel free to use the blank coding sheets provided in the module.
28 seconds]

3 second pause

Having followed the instructions you read prior to beginning this audiotape, you have already gotten a clock or a watch with a sweep second hand or a stop watch. If you do not already have such materials available, please stop the tape and get them now if you wish to use them. [18 seconds]

Background music is faded up for 10 seconds.

Now that you have the appropriate materials, please code the following seventh grade general science lesson.

2 second pause

TEACHER: Dip the end of that toothpick in that soap. Just the very end, OK? (PAUSE) Now put it right in the middle.
CHORUS: (UNINTELLIGIBLE)
STUDENT: Smell of it.
STUDENT: Lemme see that toothpick, Tracy.
CHORUS: (UNINTELLIGIBLE)
TEACHER: What happened Scott?
SCOTT: (UNINTELLIGIBLE) . . . the waves.
TEACHER: What do you say Ricky?
RICKY: I'd say it spreaded apart.
CHORUS:(UNINTELLIGIBLE).
STUDENT: Hey man, you cheated a little bit.
STUDENT: It's the soap . . . Gravity or something.
SCOTT: It's the salt.
TEACHER: It's the salt? Why do you think it's the salt somebody? Anybody?
RICKY: Scott said it. Let him answer it.
STUDENT: (UNINTELLIGIBLE) . . . got lucky. It has to be something.
SCOTT: Salt with soap combines with the fat and it separates.
TEACHER: That's a good idea. Do you have any way that we could test that?
SCOTT: Yeah.
TEACHER: How?
CHORUS: (UNINTELLIGIBLE)
STUDENT: . . . put salt on the dry deal and pour some of that in it.
TEACHER: What's that gonna show?
STUDENT: Nothing. It's just gonna get some soggy salt.
STUDENT: If we could get . . .
STUDENT: If you wanna know if its just the salt that's doing it . . . (UNINTELLIGIBLE) . . . just try to put salt in by intself . . .
RICKY: Let's get a new bottle and see what it'll do if we just stick the tooth pick in without anything on it . . .
CHORUS:No. . . . No salt just pepper . . . (etc., etc.)

STUDENT:. . . Somebody put their finger in there it separated . . .
STUDENT: . . .didn't make any difference.
TEACHER: Ricky says the salt didn't make any difference. Do any of the rest of you agree with that?
STUDENT: Yeah! It must be the pepper that does it, not the salt.
STUDENT: (UNINTELLIGIBLE) . . . add some salt.
[2 minutes]

Background fades back up for 12 seconds, then down to:

Now that you have finished coding this short episode turn to page eleven of the key booklet. Stop the tape now and check your analysis-

Background comes back up and continues uninterrupted for 12 seconds.

Coding questions as they roll by you in an ongoing classroom situation is a much more difficult task than coding the transcripts. You must focus strictly on the questions, forcing yourself to ignore all the other interesting things that are going on around you. Now that you know how intensely you must concentrate, try to code the next lesson for a 70% success level.

Background music continues unabated for 5 seconds.

TEACHER: OK, What are some of the methods that work for birth control Kevin?
KEVIN: Uh . . . Ummm . . . Prophylactics?
TEACHER: Prophylactics. OK . . . Let's see, in what way do you think that would differ from the first two we have here? (LONG PAUSE) Cecille, what do you think?
Cecille Uh . . . (LONG PAUSE)
TEACHER: Do you think it would be anything like this one? (LONG PAUSE) Which one do you think it would be closest to? (LONG PAUSE)
Cecille: Uh . . . (UNINTELLIGIBLE) . . . closest to sterilization.
TEACHER: Sterilization. All right, who . . . who agrees with her there? Does anhone . . . Sharon agrees with her, Bob, Kevin, OK. Then . . . (UNINTEL_IGIBLE) . . .explain how it would be like sterilization. How is it like sterilization?
STUDENT: Well, like . . . (UNINTELLIGIBLE)
TEACHER: That's it, that's good. That's a pretty good analysis of it. OK, let's move over to one of the other methods then. I think that's a pretty good analysis. Does anyone think that's

not right? Thinks it works a different way? . . . (UNINTELLIGIBLE) . . . like prophylactics. She says it's like sterilization because there's no semen there so you don't have any . . . uh . . . coming together of these two gametes. What do you think Russell? Do you think that's pretty close to right.

RUSSELL: Yeah I think so, . . . O.K.

TEACHER: I would think it would be but maybe somebody would have a different opinion. Well, OK, let's go on to something else then. Uh . . . what do you think about the third one? Do you think it's a reasonable method of birth control? Abstinence?

STUDENT: No.

TEACHER: O.K., Why? Why do you say that?

STUDENT: Well . . . I don't know.

TEACHER: Do you think it's very practical?

STUDENT: No.

TEACHER Do you think it's reasonable?

STUDENT: (UNINTELLIGIBLE)

TEACHER: Forrest, do you think it's practical? . . . If some country had problems and they wanted to limit their birth rate, do you think that's a reasonable . . . uh . . . method?

FORREST: (UNINTELLIGIBLE) . . .can't go without it and they'll sure think about it some time.

CLASS: General Laughter

TEACHER: O.K., Forrest . . . Explain that a little . . . People can't go without it, in other words it's unnatural.

FORREST: (UNINTELLIGIBLE)

TEACHER: O.K., that's good. That's right and . . . it's a known fact that they can't, or they don't . . . so it would be fairly safe to assume that they can't so . . . (UNINTELLIGIBLE) Sherry, do you have a question?

SHERRY: Well, uh . . . (UNINTELLIGIBLE) . . . abstinence depends on who you are, like suppose . . . (UNINTELLIGIBLE) . . . like a scientist or something and you could get so busy that . . . (UNINTELLIGIBLE)

FORREST: (UNINTELLIGIBLE)

CLASS: General Laughter

TEACHER: Allright, allright. Explain a little bit about what you mean. Explain a little bit about what you mean when . . . (UNINTELLIGIBLE).

SHERRY: (UNINTELLIGIBLE)

TEACHER: Well, I think that's good. Does anybody disagree with that?

DEBBIE: (UNINTELLIGIBLE)

FORREST: Not everybody's gonna be that'a'way-

TEACHER: Forrest, you say not everybody's gonna be that way, Debbie you said . . . (UNINTELLIGIBLE) . . .Earl, what do you think?

EARL: I think they gonna think about it one time or another. I mean . . . (UNINTELLIGIBLE).

CLASS: Genral Laughter-
TEACHER: O.K., I think all of ya'll that said that were partially correct. There's some people that it's just not as much of a problem for them. They redirect what they're doing into . . . (UNINTELLIGIBLE) . . .creative scientists or something. I think what Earl said is true too. At one time or another every body thinks about it if they're anywhere near normal at all. O.K., let's . . . uh . . . let's look at the next one then. Sterilization. Mary, what do you think? Do you think that's a reasonable method of birth control? Is that a reasonable method of birth control, say, for people in India?
MARY: Yeah, I think it is.
TEACHER: How come? Why? (LONG PAUSE)
MARY: Well . . .
STUDENT: Are you talking about as a law or (UNINTELLIGIBLE)?
TEACHER: As a law. Something to limit their population.
STUDENT: (UNINTELLIGIBLE) . . . a population that's risen and like babies born and . . .
STUDENT: . . . . . deplete the population!
TEACHER: Ben, what do you think about that? Do you think it would do that?
BEN: Naw.
TEACHER: (UNINTELLIGIBLE) . . . what do you think? Do you think it would deplete the population like he said?
STUDENT: If it did, it would take a while.
TEACHER: You say it would take a while.
[5 minutes, 58 seconds]

Background music fades up for 12 seconds, breaks for:

The magic topic. Discuss sex and they're immediately attentive. Now that you have coded this lesson, please turn to page 15 of the key booklet to check your analysis. Stop the tape now.
[17 seconds]

Background musci fades up for 12 seconds, then breaks for:

TEACHER: Scott, let's hear your idea. How many dimensions does this have?
SCOTT: One.
TEACHER: One? What is a dimension? Scott? (PAUSE) Allright Mark! what are the three dimensions Scott?

SCOTT: Uh . . .(LONG PAUSE) . . . length, depth and width?
TEACHER: Length, width and depth. Allright, what does this system have?
CHORUS: (UNINTELLIGIBLE)
TEACHER: Length?
CHORUS: Yes
TEACHER: And Width. Good
STUDENT: It's got depth too; about five thousandths of an inch.
TEACHER: David says it has depth of about five sevenths of an inch . .
DAVID: Five thousandths!
CHORUS: (UNINTELLIGIBLE)

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for about 50 seconds, students chime in with ideas but poorquality recording makes understanding what they say too difficult to transcribe.

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TEACHER: Let's go back to the idea about the dimensions. Johnny, what's different about these two bottles?
JOHNNY: One's fatter than the other one. One's . . . (UNINTELLIGIBLE)
TEACHER: Do they both have height?
STUDENTS: Yes.
TEACHER: Do they both have width?
CHORUS: Yes.
TEACHER: Do they both have depth?
CHORUS: No & "One of them doe!"
TEACHER: O.K., let's think about it. Bryan, does this have depth?
BRYAN: Which one?
TEACHER: This coke bottle.
BRYAN: Not from in front.
TEACHER: How about now?
BRYAN:Just a little bit.
TEACHER: Just a little bit. Art, do you think this coke bottle has depth?
ART: No.
BRYAN: If it didn't have depth it wouldn't be there,
TEACHER: Did you hear Bryan's comment? If it didn't have depth it wouldn't be here.
CHORUS: (UNINTELLIGIBLE)

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discussion is not transcribable for about 15 seconds due to poor technical quality of recording,

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TEACHER: O.K., We don't care how it comes out. Mine come out awkward too. Go ahead and try.
STUDENT: Well . . . uh . . . (UNINTELLIGIBLE)
TEACHER: Jimmy, how many dimensions does this coke have?
[3 minutes, 32 seconds]

Your eventual goal is the ability to ode classroom questions at the seventy percent level. Listen to the following and rest for a few minutes before proceeding to side B.

Background musci at this point is the Tocatta movement of J.S. Bach's Partita Number 6 in E Minor. It require approximately 6 minutes and 38 seconds.

Please change the tape to side B.

SIDE B

Side B begins with Herbie Hancock's "Chamelon," a composition similar to Bird's "Ethiopian Knights" which develops rhythmic complexity via the incremental addition of instruments."Chamelon" serves as the background music for all of Side B. Approximately 58 seconds plays prior to the commentary:

Another resemblance that much of jazz and much of teaching have in common is that things move so rapidly, the practitioners must work very hard just to keep up. In working through Side B you will continue coding classroom episodes from real science classes, checking your analyses with the pages in the key booklet which are referred to in the tape.

If you find yourself miscoding a specific question category, you should review the category by rereading the introduction booklet and, perhaps, by reworking the appropriate section of the written program.
[33 seconds]

Background music for 10 seconds to:

TEACHER: O.K., see you've explained to these kids, you know, the different ways that the heat, that the earth is heated. What could you tell them? Some other signs to look for? Garry?
GARRY: Uh . . . (UNINTELLIGIBLE). . . look for clouds.
TEACHER: O.K., Clouds. Clouds are actually one of the questions I was going to ask you. What about the clouds? What are they? What would you tell 'em Pat?
PAT: Some of 'em are water vapor.
TEACHER: O.K., it's water vapor. What are they condensed around? The water vapor? . . . Mitch?
MITCH: Dust particles.
TEACHER: O.K., dust particles. What about the way some clouds look different from other clouds? Right Ernie?
ERNIE: No.
TEACHER: No? They all look the same. right?
ERNIE: No they're . . . they're different.
TEACHER: O.K., and what three ways do we have of classifying them Roxanne?
ROXANNE: Cumulus, strattus, and cirrhus.
TEACHER. O.K., what's a cumulus, Renee?
RENEE: They're light and fluffy.
TEACHER. O.K., what kind . . . what kind of weather would you kind of expect with this, with white fluffy clouds out there? David?
DAVID: Fair weather.
TEACHER: O.K., pretty good, right? . . . (UNINTELLIGIBLE) . . . O.K., what's the next type? Mike?
MIKE: Strattus clouds.
TEACHER: Strattus. What would you call that? How would you describe it?
MIKE: Uh . . . just like a low thin layer?
TEACHER: That's right. And what type of weather might you expect from . . . not all the time but sometimes? JOEY?
JOEY: Rainy?
TEACHER: It might be rainy, right? It's gonna be a cloudy day . . . (UNINTELLIGIBLE) . . . sunlight. And the third type? Donald?
DONALD: It's . . . uh . . . cirrhus?
TEACHER: O.K., where would you find these cirrhus clouds, Mary Grace?
MARY GRACE: In the upper troposphere.
TEACHER: O.K., and how would you describe these? How are they different from the others?
MARY GRACE: They're like . . . uh . . . thin thin layers of like feathers.

TEACHER: O.K. What about the characteristics of the molecules that differ from the other kinds Steve
STEVE: (UNINTELLIGIBLE)
TEACHER: O.K., they're like frozen water vapor, right? Tobin?
TOBIN: They . . . uh . . . (UNINTELLIGIBLE) . . . and they're usually way up high in the atmosphere.
TEACHER: O.K., they're very high and they look like feathers. OK. So you're through this. What are two terms these people would need to know. . . . to understand about why it rains, things like this? Barry?
BARRY: (UNINTELLIGIBLE)
EACHER: Well, that's important but what two terms even before you get to this? Tommy?
TOMMY: Humidity, . . . (UNINTELLIGIBLE)
TEACHER: Well, it has to do with water vapor and humidity. Don?
DON: (UNINTELLIGIBLE)
TEACHER: It's got to do with that too. Two terms here. If you didn't know this term you really wouldn't even know what dewpoint was. Joe?
JOE: (UNINTELLIGIBLE) . . . evaporation.
TEACHER: Evaporation. That's one of 'em. What's the other one Rick? What's the opposite of evaporation?
[3 minutes, 6 seconds]

Background Music fades up for 10 seconds to:

To check your analyses, turn to page 16 of the key booklet. Stop the tape now.
[6 seconds]

Background music for 10 seconds to:

Now analyze the following eight grade life science lesson.
[4.5 seconds]

TEACHER: Kathy, did you see a nucleus in the cells of the onion skin?
KATHY: No I didn't.
TEACHER: Theresa, did you see a nucleus in the cells of the onion skin?

THERESA: (UNINTELLIGIBLE)
TEACHER:What'd you see Theresa?
THERESA: (UNINTELLIGIBLE)
TEACHER: James, what'd you see in the Elodea?
JAMES: Uh . . . I saw . . . (UNINTELLIGIBLE) . . . inside the cell and some kind of . . . (UNINTELLIGIBLE) . . . and I saw a vein.
TEACHER: You saw a what?
JAMES: A vein.
TEACHER: A vein? What does a vein look like?
JAMES: Well it's a long streak . . . (UNINTELLIGIBLE) . . . leaf.
TEACHER: A line that runs down the middle of a leaf? James, how'd you know it was a vein?
JAMES: I just looked at it.
TEACHER: Microviewer? Kent, did you see the vein?
KENT: Yes.
TEACHER:Did the cells look different in the vein than anywhere else in the leaf?
KENT: Yes.
TEACHER: How did they look?
KENT: (UNINTELLIGIBLE) . . . in a straight line.
TEACHER: Good! Thery were straight. Why were they straight?
KENT: Because the vein was straight.
TEACHER: Because the vein was straight? Gina, why would the cells be straight in the vein?
GINA: I don't know . . . (INAUDIBLE) . . . I don't know.
TEACHER: No, you've got a good idea. Finish what you were saying.
GINA: You know when the veins are . . . (INAUDIBLE).
TEACHER. I couldn't hear the end.
GINA: I don't know.
STUDENT: (UNINTELLIGIBLE)
TEACHER: I Couldn't hear her.
STUDENT: She said the cells are straight because the veins are straight and . . . (UNINTELLIGIBLE).
TEACHER: Could ya'll hear back there?
CHORUS: No!
TEACHER: She said the cells are straight because the veins are straight. The cells make up the straight veins-
STUDENT: Well why are the veins straight?
TEACHER: Why <u>are</u> the veins straight, Gina? (PAUSE) Can you think of a reason? (PAUSE) Why is it straight instead of crooked like this?
GINA: Idon't know.
TEACHER: You want to think about it a minute? (PAUSE) O.K. Carl?
CARL: Well, wouldn't the cells take on the shape of the cell membrane . . . (UNINTELLIGIBLE) . . . cell membranes were straight that's why the cell would be like that.

TEACHER: Allright. David, I want to go back to this idea of why the vein is straight. Why don't you tell us why the vein is straight instead of being crooked like this?
DAVID: One idea is that it grows toward the sun and . . . (UNINTELLIGIBLE) . . . because the nucleus just goes toward the sun. Anyway, there's nothing to stop it, I mean if there's a twig in the way, it would, I mean the twig would be in the way so it . . . (UNINTELLIGIBLE) . . . grows toward the sun.
TEACHER: That might be a real good reason why it grows straight.
STUDENT: (UNINTELLIGIBLE) . . . grows toward the sun?
STUDENT: Yeah, how come all trees aren't straight?
TEACHER: Why aren't all tress straight?
STUDENT: It might be planted crooked.
TEACHER: Do you think that has anything to do with it?
STUDENT: It might.
TEACHER: That's a good idea.
STUDENT: (UNINTELLIGIBLE)
TEACHER: Right.
STUDENT: It could have been split.
TEACHER. It could have been split.
STUDENT: There could have been a rock on it, on top of the seedling and the rocks made it grow off to one side.
TEACHER: Possibly. Possibly. Fred, did you have a comment?
FRED: (UNINTELLIGIBLE)
TEACHER: O.K., say that loud so they ca- hear you.
FRED: (UNINTELLIGIBLE).
TEACHER: Gina, does that make sense to you?
GINA: Uh-huh.
TEACHER: It's a good idea, isn't it?
[5 minutes, 15 seconds]

Background Music for 12.5 seconds to:

To check your analysis, turn to page 13 of the key booklet. Stop the tape at the tone. . . . . (tone)
[9 seconds]

Background Music for 11 seconds to:

Now analyze this classroom lesson.
[3 seconds]

TEACHER: O.K., are there different kinds of energy?
STUDENT: Yes.
TEACHER: O.K., what kinds of energy are there?
STUDENT: O.K., there's light energy and heat energy and kinetic energy and . . . that's it.
TEACHER: What are the two broad areas of energy? There are two general areas and . . . (UNINTELLIGIBLE).
STUDENT: Kinetic is one of 'em.
TEACHER: O.K. kinetic is one of them. Bryan?
BRYAN: (UNINTELLIGIBLE)
TEACHER: I said there are two possible forms of energy. Ken said kinetic is one of them. What's the other.
BRYAN: Potential.
TEACHER: Potential. That's right. O.K., what's potential energy?
STUDENT: It's energy that's stored.
TEACHER: O.K., real good. Real good. What about kinetic energy? What kind of energy is that?
BRYAN: (UNINTELLIGIBLE)
TEACHER: O.K., well now, we're talking about potential and kinetic energy. How do we apply this to heat? . . . (UNINTELLIGIBLE) . . . . said that heat is energy, so how does this relate? Bryan?
BRYAN: (UNINTELLIGIBLE) . . . well if something gets hotter, it moves faster.
TEACHER: O.K., when something gets hotter, it moves faster. Now, what do you mean by that?
BRYAN: (UNINTELLIGIBLE)
TEACHER: O.K., so by that I assume you mean that the molecules that are in everything that are moving. . . O.K., what about . . . (UNINTELLIGIBLE) . . . What is heat? (Sounds of teacher working at chalk board) . . . O.K., we're saying that everything has molecules in it and they're in motion- Do you think this can be applied to heat?
[2 minutes, 42 seconds]

Background music for 5 seconds to:

To check your analysis, please turn to page 14. . . Stop the tape now.
[8 seconds]

Background music for 5 seconds to:

Now analyze the following short sequenc
[2 seconds]

TEACHER: . . . additional things. Give me some specific t:pe things that you . . .
STUDENT: Like cubes.
TEACHER: O.K., cubes are one thing.
STUDENT: Cones.
TEACHER: Cones.
STUDENT: Spheres.
TEACHER: Spheres. . . . . What in your every day life uses volume or who uses volume?
CHORUS: (UNINTELLIGIBLE)
TEACHER: Nobody uses volume?
CHORUS: (UNINTELLIGIBLE)
TEACHER: You do?
STUDENT: (UNINTELLIGIBLE)
TEACHER: How . . . Cleaning . . . (UNINTELLIGIBLE) . . . ?No, what . . . How . . . Why do you think that's volume?
STUDENT:(UNINTELLIGIBLE)
TEACHER. That is to say, how is it expressed? What units?
STUDENT (UNINTELLIGIBLE)
TEACHER (UNINTELLIGIBLE) . . . in volume and gasoline in gallons. Anything else?
STUDENTS: (UNINTELLIGIBLE)
TEACHER: All right, O.K., I guess they charge by the cubic feet. Natural gas is . . . that's how you pay for it, in cubic feet. Water, liquids are all measured in volume.
STUDENT: What about textiles?
TEACHER: Textiles. All right let me . . . What?
STUDENT: (UNINTELLIGIBLE)
TEACHER: How . . . How would you . . . How . . . What do you mean by textiles? Materials?
STUDENT: Cloth, metal.
TEACHER: And how would you buy a sheet of metal? What are they expressed in?
STUDENT: They're bought by the square yard.
TEACHER: Allright, that'd be area. If you . . . (UNINTELLIGIBLE) . . . squared, remember? Cause you had centimeters to the one, centimeters to the two, centimeters to the three which is area would be . . . wouold be square feet or whatever. A lot of building contractors figure their buildings by the square foot.
[1 minute 38 seconds]

Background music fades in for 12 seconds to:

To check your analysis, please turn to page 12 of the key booklet. Please stop the tape.
[6 seconds]

Background Music plays for 12 seconds and fades down for:

> Your analysis of questioning skills should be honed to a fine edge by this time. You are now ready to take your final examination. Please code the following eighth grade earth science lesson for different types of questions asked.
> [17 seconds]

TEACHER: Today we're gonna talk about economically valuable minerals. Darin, what's economically valuable minerals?
DARIN: I don't know.
TEACHER: What's economic . . . economics?
DARIN:Oh that's . . . uh . . . sometin' like gold or diamonds.
TEACHER: Darin says economics is like gold or diamonds. Tammy?
TAMMY: (UNINTELLIGIBLE)
TEACHER: O.K., Tammy says economics . . . economically valuable minerals are minerals that are worth money. Do you agree with that Jimmy?
JIMMY: Yes.
TEACHER: Jimmy agrees. Allen?
ALLEN: Yeah, I guess so.
TEACHER: That's what it is. The minerals that are worth money. O.K._ what I want to do is to put a list up here with minerals that ya'll think are worth money. . . . . O.K., Ruben, give me a valuable mineral.
RUBEN: A valuable mineral?
TEACHER: A valuable mineral.
RUBEN. Diamond.
TEACHER: Diamonds. . . . Joanne, can you name one?
JOANNE: Uh . . . ruby?
TEACHER: Ruby. . . . . Jeff?
JEFF: Gold.
TEACHER: Gold . . . .
STUDENT: Topaz.
TEACHER: Do ya'll think . . . do ya'll agree with Jeff that gold's a valuable mineral?
CHORUS: Yes.
TEACHER: O.K., Kevin, do you think gold's valuable?
KEVIN: (UNINTELLIGIBLE)
TEACHER: Well, what does that mean? Yes or no?
KEVIN: Yes.
TEACHER: Yes. Why do you think gold's valuable?
KEVIN: Because it's hard to find.
TEACHER: It's hard to find. O.K., Michelle, do you agree that that's one reason why gold is valuable? Because it's hard to find?

MICHELLE: Yeah.
TEACHER: O.K., why do you think it's a criteria for being valuable? That it's hard to find? Why is that a reason? I'm asking Michelle.
MICHELLE: Because if you can't find it, then it's hard . . .
ALLEN: If you can't find it, it's hard to make money on . . .
STUDENT No! . . . Mr Harkins!!
TEACHER : O.K., Allen said that if you can't find it, you don't have that much. That's what Michelle said, and they said if you don't have much, it's worth more because people want it- Is that what you said, more or less?
ALLEN: Yeah . . . (UNINTELLIGIBLE) . . . money on it.
TEACHER: Connie?
CONNIE: Well, if nobody has it, then some women like it.
TEACHER: Ah! Connie says it's valuable because women like it and if they can have it and their friends can't, that makes 'em feel . . .
STUDENT: Feel <u>good</u>!
DARIN: That's a girl's opinio, though.
TEACHER: That's a girl's opinion Darin.
DARIN: Numberfour can be sapphire.
TEACHER: O.K., Darin says the fourth mineral can be sapphire . . . Why sapphire, Darin?
DARIN: It's just . . .
JIMMY: It's pretty!
DARIN: . . . pretty and the ladies like it and everybody likes it.
TEACHER: O.K. Darin and Jimmy both seem to agree. Sapphire is pretty. Connie, if sapphire is pretty, why is it valuable?
CONNIE: Because women will buy some of it.
TEACHER: O.K., because women will buy some of it. So will men. Men'll buy it . . .
CONNIE: For their wives.
TEACHER: Naw, they don't give it to their wives- Only to their girl friends. You don't give anything good to your wife.
CHORUS: (UNINTELLIGIBLE)
TEACHER: O.K., Jerry, number six.
STUDENT: Number five is turquoise.
TEACHER: It's <u>WHAT</u>?
CHORUS: TURQUOISE!!!
TEACHER: Turquoise. Waitaminit! You gotta pick one that's easy for me to spell. How do you spell that?
CHORUS: (UNINTELLIGIBLE)
TEACHER: Ya'll know what it means. Turquoise. Something like that. Turkwees. . . . turkwees.
CHORUS: General Laughter

TEACHER: O.K., That's Jerry's. Why turquoise?
JERRY: Because it's pretty. It's . . . uh . . . good for jewelry and . . . it's pretty whenever you got it.
STUDENT: It's hard to come by too.
STUDENT: I got number six.
STUDENT: What's the most valuable mineral in the world?
STUDENT Diamond.
TEACHER: O.K., Connie, did you have something to add to the conversation? . . . Shhh. . . Shhh. . . Connie's talking.
CONNIE: (UNINTELLIGIBLE)
TEACHER: O.K., Connie says a lot of these minerals are valuable because of their hardness. How hard's a diamond?
STUDENT: The hardest thing on earth.
TEACHER: O.K., how hard's gold?
JIMMY: It's soft. It's soft but that makes it easy to shape.
TEACHER: Jimmy says it's soft. That's one reason why gold is valuable. Because it's soft and it's easy to shape. They can stretch it into these thin little wires.
STUDENT: Yeah, but they cut diamonds real good.
TEACHER: Yeah, but diamonds cut everything else real good. O.K., Kevin, number six.
KEVIN: Jade.
TEACHER: Jade.
STUDENT: That's like sapphire . . . because it's pretty.
TEACHER: O.K., it's like sapphire, like the others, like ruby and sapphire and turquoise, it's pretty.
DARIN: Mr. Harkins, I got one.
TEACHER: Darin?
DARIN: Am-the-ist? What's that word?
STUDENT: Amethyst.
TEACHER: Amethyst. O.K., Amethyst.
STUDENT: That's only semi-precious.
DARIN: That means it's valuable, though.
TEACHER: Semi-precious. Who said that? Tracy? Why is it a semi-precious stone?
TRACY: (UNINTELLIGIBLE)
TEACHER: He says that the amethyst is not as valuable as sapphire because it's softer, it's . . . (UNINTELLIGIBLE) . . ., it fractures and . . .
STUDENT: It can't be alloyed.
TEACHER: It can't be what?
STUDENT: Alloyed. Gold can be alloyed so it'll be harder.
TEACHER: What about sapphire? You can't make metal out of sapphire can you?

STUDENTS: (UNINTELLIGIBLE)
TEACHER: O.K., number eight. . . Raise your hand. Who said . . .
Allen and Walter said what?
CHORUS: Silver.
TEACHER: Good! Silver! . . . I'm wondering. Usually it's this one and then this one, the first two. And this one. O.K., silver. Why is it economically valuable Erik?
ERIK: Because a lot of silver is used in knives and forks and spoons.
TEACHER: Yeah, and it's used in teeth.
STUDENT: Teevees.
CHORUS: (UNINTELLIGIBLE)
TEACHER: Waitaminit, waitaminit. Jerry, what did you say?
JERRY: Money.
TEACHER: Money. What do all these things have on 'em?
STUDENT: Nickel.
STUDENT Silver!
TEACHER: Silver.
STUDENT: Nickel. It's nickel-plated copper.
STUDENT: It's silver-coated.
STUDENT: I'll betcha.
TEACHER: Nickel-plated copper.
CHORUS: (UNINTELLIGIBLE)
TEACHER: O.K., what'd they use to be before 1964?
CHORUS: Silver!!!
TEACHER: Silver.
CHORUS: (UNINTELLIGIBLE)
TEACHER: O.K., that's the reason why silver's valuable. Good, Jerry. Darin, you have another one?
DARIN: Yeah. Nickel's a valuable mineral.
TEACHER: Number nine! Nickel!!
CHORUS: (UNINTELLIGIBLE)
DARIN: It's used for coins.
TEACHER: It's used for coins. All these . . .
STUDENT: That's spelled wrong. It's "-el"
TEACHER: O.K., "-el." O.K., Jeff?
JEFF: Brass?
TEACHER: Brass?
ALLEN: (UNINTELLIGIBLE)
TEACHER: What'd you say, Allen?
ALLEN: Copper.
TEACHER: Copper. Excellent.
STUDENT: That's expensive, too.
CHORUS: (UNINTELLIGIBLE)
RUBEN: Pooter, or whatever you call it.
TEACHER: Oh, but Ruben, that's not valuable. Pewter's cheap. . .

. . . Good try. . . O.K., now ya'll <u>think.</u> Economically valuable minerals are those . . . are those which are worth lots of money.
[9 minutes, 24 seconds]

Background music 5 seconds to:

Please turn to page 18 of the key booklet.
[2 seconds]

Background music for 13 seconds to:

Congratulations. You have finally finished the module with a coding accuracy at the 70% level. This level is exceptionally good and should not be judged by the typical ten-point scale. A 70% accuracy level for coding questions of this nature would be equivalent to an A, not a C. This is the end of the module.
[1 minute, 3 seconds]